ISSN 0018-019X

Erscheint 9mal jährlich - Paraît 9 fois par an

104. Diastereoselective Synthesis of Nitroaldol Derivatives[1])

by **Dieter Seebach, Albert K. Beck, Triptikumar Mukhopadhyay[2])** and **Elizabeth Thomas[3])**

Laboratorium für Organische Chemie der Eidgenössischen Technischen Hochschule, ETH-Zentrum, Universitätstrasse 16, CH-8092 Zürich

(31.III.82)

Summary

Three methods are described by which diastereomerically enriched nitroaldols and their *O*-silylated derivatives can be prepared. *threo*-Nitroaldols prevail up to 10:1 over the *erythro*-isomers if doubly deprotonated nitroaldols **28** are quenched with acetic acid (THF/HMPT or DMPU, −100°) (see *Scheme 5* and *Table 2*). *O*-Trimethyl- or *O*-(*t*-butyl)dimethylsilylated (TBDMSi) *erythro*-nitroaldols can be obtained by protonation of the corresponding lithium nitronates (**35**, **39**) in THF at low temperature (see *Schemes 6* and *7*). The *erythro-O*-TBDMSi-nitroaldol derivatives are also formed in the fluoride catalyzed addition of TBDMSi-nitronates (**40–45**) to aldehydes (see *Schemes 8* and *9*). In the latter reaction no 1,2-asymmetric induction is observed if α-branched silylnitronates or aldehydes are employed (see **48/49** and **50/51**). - The stereochemical course of the reactions leading to *erythro-O*-TBDMSi-nitroaldols follows topological rules of broad applicability (see *Scheme 10*); possible mechanisms are discussed. - The configuration of *erythro/threo*-nitroaldols is determined by chemical correlation (see **24–26**) and by ^{13}C-NMR. spectroscopy. - Some examples of the preparation of diastereomerically enriched 1,2-aminoalcohols by reduction of the corresponding nitro compounds without loss of configurational purity are described (see *Schemes 11* and *12*).

A) Introduction. - The nitroaldol- or *Henry* reaction is one of the classical C,C-bond forming processes. It furnishes the 1,2-functionalized nitroalcohols **1**, precursors of the symmetrical ($R^1 = R^2$) and unsymmetrical ($R^1 \neq R^2$) aminoalcohols **2**. Nitroaldols have been extensively reviewed [3] [4], and have frequently been used as intermediates in synthesis. However, the lack of stereoselectivity in the *Henry* reaction (except in cyclic systems) has hardly been mentioned. This lack of selectivity is due to the reversibility of the reaction and the easy epimerization at the nitro-substituted C-atom. The nitroaldols of type **1** ($R^1, R^2 \neq H$) occur in two dia-

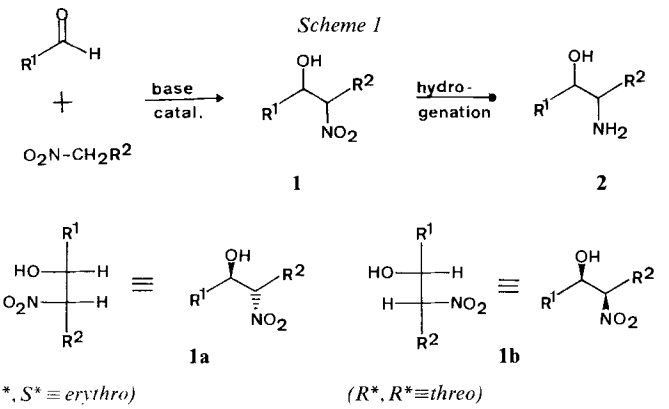
[1]) Part of the results described here was mentioned previously in a review article [1] and in a communication [2].

[2]) Postdoctoral research fellow, ETH Zürich, 1981/82.

[3]) Royal Society Postdoctoral Fellow, ETH Zürich, 1981.

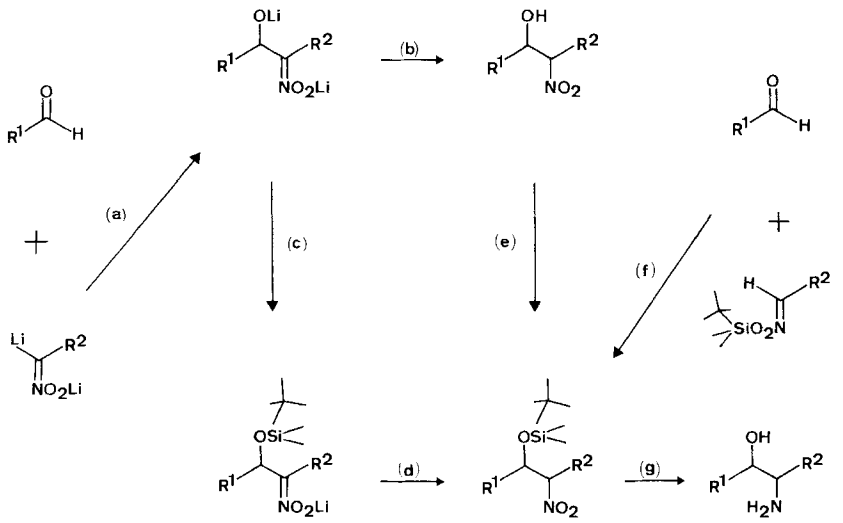
0018-019X/82/4/1101-33$01.00/0

Scheme 1



stereomeric forms, the *erythro-* (**1a**), and the *threo-* (**1b**) isomers[4]). A stereoselective synthesis of either of these isomers would be highly desirable. In the course of our work on the modification of the nitroaldol reaction [2] we noticed in several cases that the derivatives isolated were diastereomerically enriched. Thus, when the primary product of the addition of doubly deprotonated nitropropane to benzaldehyde (see *reaction a* in *Scheme 2*, $R^1 = C_6H_5$, $R^2 = C_2H_5$) was treated with acetic acid at low temperature, the nitroalcohol formed (*reaction b* in *Scheme 2*) and its

Scheme 2



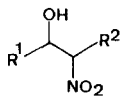
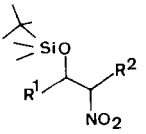
(a) Addition of α-lithio lithium nitronates to aldehydes. (b) Protonation of the primary adducts with HOAc at low temperatures; (c) *In situ* monosilylation of the primary adducts from (a). (d) Protonation of *O*-silylated nitroaldol nitronates with HOAc at low temperatures. (e) Silylation of a nitroaldol at the hydroxyl O-atom with TBDMSiCl/imidazole. (f) Fluoride-catalyzed silylnitroaldol reaction. (g) Desilylation and reduction of the NO_2-group to give a vicinal aminoalcohol.

[4]) With one exception (see **42**→**50**+**51**) all reactions described in this paper were done with *d,l*-materials, while the *formulae* show only one enantiomer.

silylated derivative (see *reaction e*) were enriched in one isomer [5]. In contrast, mono-silylation *(reaction c)* of the dianion followed by protonation *(reaction d)* led to a product enriched in the other isomer [2] [6]. Furthermore, the fluoride-catalyzed silyl nitroaldol reaction (*f*) was occasionally found to be stereoselective for reasons which were not obvious at that time [7]. Reduction *(reaction g)* with lithium aluminium hydride gave the corresponding aminoalcohol with loss of any diastereomeric enrichment which might have been present in the *O*-silyl-nitroaldol precursor [7].

In the meantime we have systematically followed up the above observations, and this has now led both to *threo*- and especially *erythro*-selective modifications of the nitroaldol reaction.

B) Base-catalyzed preparation of nitroaldols and configurational assignment by ^{13}C-NMR. spectroscopy and by chemical correlation. – The nitroalcohols **3–12** were prepared using a modification of the known procedure [8] which involves treatment of the corresponding nitro compound with an aldehyde and a catalytic quantity of sodium hydroxide. In every case the products were mixtures of diastereoisomers according to the ^{1}H-[5]) or ^{13}C-NMR. spectra. In all cases the ratios could be determined (see *Table 1*).

3–12  **a:** *erythro* **b:** *threo*  **13–22**

	3/13	4/14	5/15	6/16	7/17	8/18	9/19	10/20	11/21	12/22
R^1	C_2H_5	C_3H_7	C_5H_{11}	C_5H_{11}	C_3H_7	$C_{10}H_{21}$	C_5H_{11}	$(CH_3)_2CH$	C_3H_7	C_6H_5
R^2	C_2H_5	C_2H_5	CH_3	C_2H_5	C_7H_{15}	CH_3	C_7H_{15}	C_2H_5	$(CH_3)_2CH$	C_2H_5

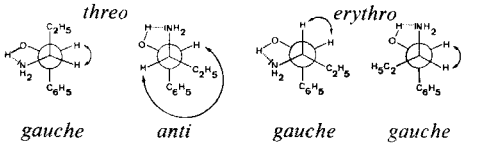
We have assigned the *threo*-configuration **b** to the prevailing isomer on the basis of the following results:

a) Raney-nickel reduction of the nitroalcohols furnishes aminoalcohols of type **2** which have been shown [9] to exhibit a larger (*ca.* 6 Hz) vicinal coupling between the α-N–CH and the α-O–CH for the *threo*-isomer and a smaller (*ca.* 4.5 Hz) in the *erythro* case[6]). This NMR. assignment[7]) has been mainly applied to 2-amino-

[5]) ^{1}H-NMR. spectroscopic determination of the ratio of diastereomers is especially easy in the case of adducts **12, 22, 30–34, 46, 47** to aromatic aldehydes.

[6]) See the NMR. spectra of the aminoalcohols from **6**, **7**, **8**, **12**, **15**, **16**, **18**, **26** and **29** as described in the *Experimental Part*.

[7]) It rests upon the assumption that those conformations are more highly populated in which the vicinal OH- and NH_2-groups can form H-bonds, *i.e.* are in a *gauche* or *synclinal* relationship:



J(H–C,H–C) = 6 Hz J(H–C,H–C) = 4.5 Hz

Table 1. *^{13}C-NMR. signals of a series of mixtures of diastereomeric aliphatic nitroaldols from the classical* Henry *reaction and their O-silylated derivatives.* Chemical shifts in δ[ppm] and ratio of intensities. The high-field α-O-^{13}C-signal and low-field α-N-^{13}C-signal are assigned to the *threo*-isomer (exception: nitroaldol **5**). Most of the ratios were determined using pulse-delay techniques with integration, although pulse-delay was later found not to be necessary. Relative chemical shifts of α-O_2N-^{13}C-signals are more diagnostic due to larger chemical-shift difference between the two isomers.

	Nitroaldol			*O*-Silylated nitroaldol	
	α-HO–C	α-O_2N–C		α-TBDMSi–O–C	α-O_2N–C
3	73.0; 72.7 (37:63)	94.1; 93.4 (63:37)	**13**	74.2; 73.4 (31:69)	93.7; 92.6 (69:31)
4	72.1; 71.6 (39:61)	94.4; 94.0 (66:34)	**14**	73.4; 73.1 (29:71)	94.3; 93.4 (71:29)
5	72.6; 72.2 (54:46)	87.6; 86.2 (54:46)	**15**	73.8	87.1; 85.5 (50:50)
6	72.1; 71.7 (40:60)	94.5; 93.9 (58:42)	**16**	73.6; 73.3 (34:66)	94.3; 93.3 (67:33)
7	72.0; 71.7 (23:77)	93.0; 92.4 (77:23)	**17**	73.5; 73.3 (63:37)	92.7; 91.7 (69:31)
8	72.8; 72.2 (50:50)	87.7; 86.4 (58:42)	**18**	73.8	87.0; 85.5 (50:50)
9	72.5; 72.1 (38:62)	93.0; 92.5 (53:47)	**19**	73.7; 73.3 (34:66)	92.6; 91.6 (67:33)
10	77.1[a]); 76,5	92.6; 92.0 (65:35)	**20**	78.4; 77.9 (44:56)	94.5; 92.3 (56:44)
			21	70.8; 70.5 (67:33)	97.7; 96.7 (33:67)

[a]) This signal overlaps with the central $CDCl_3$-singal – no ratio could be measured.

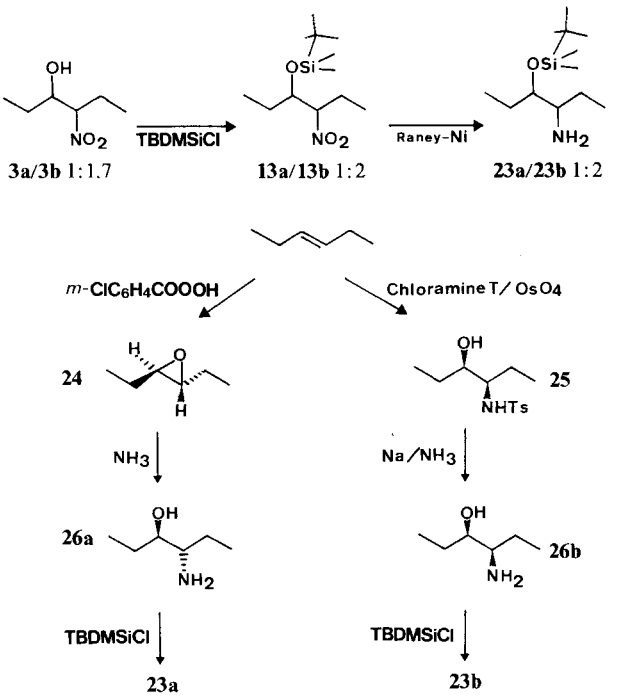
1-arylalcanols (*Scheme 1*, **2**, R^1 = aryl) [9]. It is less useful in the aliphatic series because of smaller shift differences and more complex coupling patterns.

b) A ^{13}C-NMR. assignment of the configuration of nitroaldols resulted from the following observation: in the ^{13}C-NMR. spectra of *aliphatic* nitroaldols obtained from the *Henry* reaction, the α-O–C-signals (71.6–76.5 ppm) of the major isomers lay at higher field (by 0.2–0.6 ppm) and the α-O_2N–C-signals (87.6–94.5 ppm) at lower field (by 0.4–1.4 ppm) than those of the minor isomers. As shown in *Table 1*, this chemical-shift difference remains unchanged when the hydroxy groups of the nitroaldols **3**–**11** are silylated using (*t*-butyl)chlorodimethylsilane (TBDMSiCl)/imidazole to give the compounds **13**–**21**. Since the relative intensities of the ^{13}C-NMR. signals do not change significantly on silylation we assume that the major isomers in the mixtures of *O*-silyl-nitroaldols **13**–**21** have the same configuration as those in the nitroaldol precursors **3**–**11**. Normally, one of the two diastereomers of 1-aryl-2-nitro-alcohols shows the α-NO_2–C- *and* the α-RO–C-signals at lower field (see spectroscopic data in the *Experimental Part.*

Based on some chemical correlations with aminoalcohols of known configuration (see *a* above and *c* below) we herewith assign the *threo*-configuration to those nitroaldols and their *O*-silyl derivatives, in the ^{13}C-NMR. spectra of which the α-NO_2–C signal appears at lower field.

c) In one case we established by independent synthesis that the major isomer from a *Henry* reaction has the *threo*-configuration. In order to avoid synthetic complications due to non-regioselective formation of constitutional isomers (see also discussion in section **F**), we chose the symmetrically substituted derivative **3** ($R^1 = R^2$). A 1:1.7 mixture of **3a** and **3b** was silylated giving **13a** and **13b** such that the diastereoisomeric ratio only changed to 1:2 (see also *Table 1*). Hydrogenation over *Raney*-nickel gave the *O*-silylated aminoalcohols **23a** and **23b**, also in the ratio 1:2. The same compounds **23a** and **23b** were independently synthesized[4])

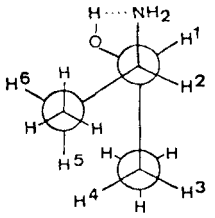
Scheme 3



starting from *trans*-3-hexene *(Scheme 3)*. Epoxidation to the *trans*-oxirane **24** [10], ring opening with ammonia to **26a** and *O*-silylation furnished exclusively the *erythro*-derivative **23a**. *cis*-Hydroxyamination of the same olefin by the method of *Sharpless et al.*, sodium/liquid ammonia reduction [11] and *O*-silylation led to the pure *threo*-isomer **23b**. NMR. comparison of the three independently synthesized *O*-silylated aminoalcohols **23** established the *threo*-configuration of the major component **3b** of the *Henry*-reaction product. The coupling constants measured from the 300-MHz-^{1}H-NMR. spectra of the aminoalcohols **26a** and **26b** were in accordance with the previously made assignments: the vicinal coupling constant between the H-atoms on the α-heterosubstituted C-atoms in the *threo*-isomer is larger than in the *erythro*-isomer (see the *Newman* projections and the data in *Scheme 4*). The *O*-silylated aminoalcohols **23a** and **23b** were also used for configurational assignment of samples obtained *via* other routes (see *Sections* **D** and **E**).

C) *threo*-Enriched nitroaldols *via* diastereoselective low-temperature protonation of doubly deprotonated nitroaldols. – As mentioned in the *Introduction*, we noticed earlier that the addition of α,α-doubly deprotonated nitropropane (**27**, $R^2 = C_2H_5$, see *Scheme 5*) to benzaldehyde led [5] [6] to a *threo*-enriched product **12b**. The dilithio derivative of type **28**, which contains a lithium-alkoxide and a lithium-nitronate group, must have been protonated diastereoselectively. The degree of selectivity depended strongly upon the presence of hexamethyl phosphoramide (HMPT) (see *Table 2*). In an independent study [12], we showed that HMPT can

Scheme 4



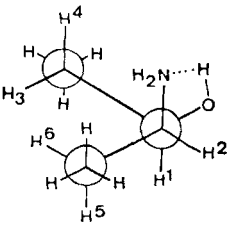
α-HO–CH^1: 2 *gauche*(H^2,H^3)/1 *anti*(H^4)

α-H$_2$N–CH^2: 2 *gauche*(H^1,H^5)/1 *anti*(H^6)

erythro (**26a**)

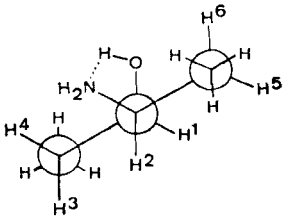
J = 3.98, 3.98, 8.62 Hz

J = 3.94, 3.98, 9.16 Hz



2 *gauche*(H^2,H^3)/1 *anti*(H^4)

2 *gauche*(H^1,H^5)/1 *anti*(H^6)



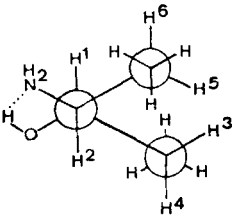
α-HO–CH^1: 2 *gauche*(H^2,H^3)/1 *anti*(H^4)

α-H$_2$N–CH^2: 2 *gauche*(H^1,H^5)/1 *anti*(H^6)

threo (**26b**)

J = 4.05, 5.68, 8.19 Hz

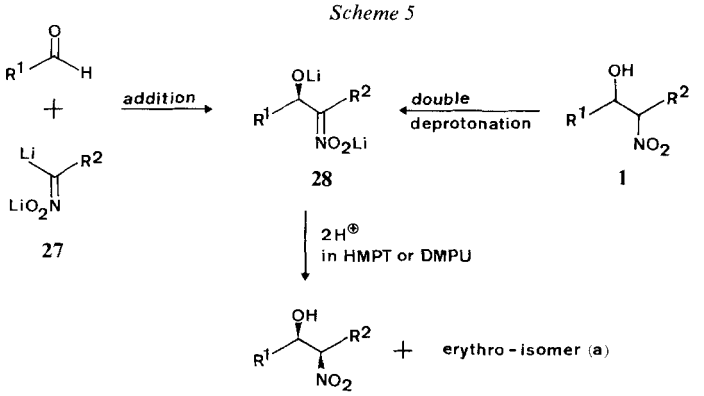
J = 4.35, 5.68, 10.17 Hz



1 *gauche*(H^3)/2 *anti*(H^2,H^4)

1 *gauche*(H^5)/2 *anti*(H^1,H^6)

Scheme 5



27 **28** **1**

4b, 5b, 10b, 12b, 29b–34b

	29	**30**	**31**	**32**	**33**	**34**
R^1	$C(CH_3)_3$	*p*-$CH_3C_6H_4$	*o*-$CH_3OC_6H_4$	*p*-$CH_3OC_6H_4$	*o*-FC_6H_4	*p*-FC_6H_4
R^2	C_2H_5	C_2H_5	C_2H_5	C_2H_5	C_2H_5	C_2H_5

Table 2. threo-*Enriched nitroaldols through protonation of* **28** (Scheme 5). For the *threo*-contents before double deprotonation see *Table 1*. Also note that the major diastereomer of the product **33** from *o*-fluorobenzaldehyde is *threo* with 25% DMPU-cosolvent and *erythro* with 33% of the same cosolvent.

Precursor	THF/cosolvent ratio in the protonation step	Product	*Threo/erythro* ratio after protonation
4	83:17 (HMPT)	**4**	72:28
27($R^2 = CH_3$) + hexanal	80:20 (HMPT)	**5**	81:19
10	83:17 (HMPT)	**10**	78:22
27($R^2 = C_2H_5$) + 2-methylpropanal	83:17 (HMPT)	**10**	78:22
12	83:17 (HMPT)	**12**	85:15
27($R^2 = C_2H_5$) + benzaldehyde	83:17 (HMPT)	**12**	90:10
	91:9 (HMPT)	**12**	80:20
	95:5 (HMPT)	**12**	57:43
	100:0 (HMPT)	**12**	50:50
	75:25 (DMPU)	**12**	90:10
27($R^2 = C_2H_5$) + pivalaldehyde	83:17 (HMPT)	**29**	85:15
27($R^2 = C_2H_5$) + *p*-tolualdehyde	75:25 (DMPU)	**30**	89:11
27($R^2 = C_2H_5$) + *o*-anisaldehyde	80:20 (HMPT)	**31**	69:31
	67:33 (DMPU)	**31**	75:25
27($R^2 = C_2H_5$) + *p*-anisaldehyde	67:33 (DMPU)	**32**	94:6
27($R^2 = C_2H_5$) + *o*-fluorobenzaldehyde	80:20 (HMPT)	**33**	71:29
	75:25 (DMPU)	**33**	68:32
	67:33 (DMPU)	**33**	22:78
27($R^2 = C_2H_5$) + *p*-fluorobenzaldehyde	67:33 (DMPU)	**34**	92:8

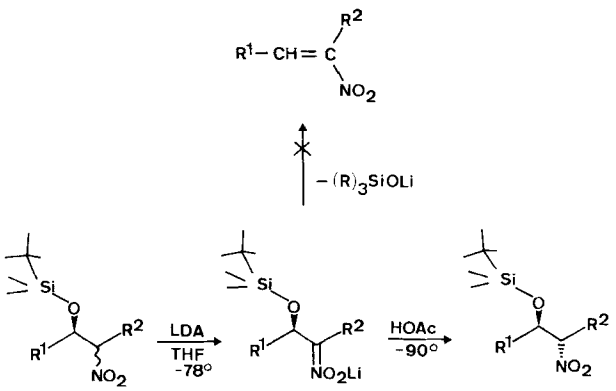
be replaced by the cyclic urea DMPU[8]) (for examples see also *Table 2*). We have now confirmed[9]) that the selective protonation of **28** is possible with other groups R^1 and R^2 in the starting materials of the addition (**5**, **12**, **29**–**34** in *Scheme 5*). We were also able to increase further the *threo*-content of the nitroaldols of type **1** (from the *Henry* reaction) by double deprotonation giving the same dilithio derivatives **28** which are formed by addition of **27** to an aldehyde, with subsequent protonation to **4**, **10** and **12**. The recovery of nitroaldol is *ca.* 50%. The results are summarized in *Table 2*. Assignment of the *threo*-configuration was again made on the basis of ^{1}H- and ^{13}C-NMR.-spectroscopic comparison (see *Exper. Part* and *Section* **B**).

D) *erythro-O*-Silylated nitroaldols by deprotonation/protonation of diastereomeric mixtures *13–22*. – When a diastereomeric mixture of *O*-TBDMSi-protected nitroalcohols **13**–**22** is treated with lithium diisopropylamide (LDA) in tetrahydrofuran (THF) at dry-ice temperature, a solution of the nitronate **35** is formed. As indicated in *Scheme 6*, under the conditions used (the temperature of the reaction mixture being maintained below $-50°$) R_3SiOLi-elimination from the nitronate to form a nitroolefin was not observed. The asymmetric C-atom bearing the nitro group was regenerated by quenching the solution of the nitronate **35** with acetic acid/THF 1:1 at bath temperatures of *ca.* $-100°$. This protonation takes place

[8]) *N,N'*-Dimethyl-*N,N'*-propylene urea; systematic IUPAC name: 1,3-Dimethyl-2-oxo-hexahydropyrimidine.

[9]) Interestingly, only the *o*-fluorobenzaldehyde behaves differently (see **33** and *Table 2*).

Scheme 6



13–22 (a+b) **35** **13a–22a**

% erythro (**a**) content of

	13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Before deprotonation (see *Table 1*)	35	30	50	35	35	50	35	50	66	25
After protonation of **35** (%ds)[10])	> 95	90	> 95	> 90	82	> 95	> 90	> 95	> 95	84

with high diastereoselectivity; the *erythro*-derivatives (**a**) of the silylated nitroaldols **13–22** are the major products, see *Scheme 6*[11]).

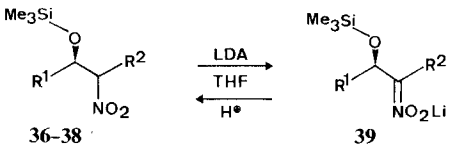
In this investigation we mainly used the (*t*-butyl)dimethylsilyl derivatives **13–22** of nitroaldols for two reasons: *a*) they are conveniently stable and can be handled and subjected to many reactions without loss of the protecting group[12]), and *b*) only the TBDMSi-derivatives can be prepared diastereoselectively by the silyl-*nitroaldol* reaction which will be discussed in the following section. In three cases, we have tested whether the less expensive trimethylsilyl (TMSi) protecting group is suitable for the deprotonation/protonation procedure with enrichment of a diastereomer. As far as general statements are possible from the three experiments described in *Scheme 7* it appears that the *erythro*-diastereomers (assignment *cf. Table 1*) are again formed preferentially, more so with aliphatic derivatives. In order to obtain

[10]) % ds gives the diastereoselectivity or the content of a certain diastereomer in a mixture of diastereomers [13].

[11]) In many cases, in fact, we could not even detect the *threo*-isomer by ^{13}C-NMR. spectroscopy: the %ds-values[10]) in *Scheme 6* were determined from the ratios of intensities of the α-O_2N–C-signals of the diastereomeric products **13–22** (**a+b**) *(cf. Table 1)*. In the initial experiments, which developed from the work with doubly deprotonated nitroalkanes [5] [6], we used THF containing HMPT as cosolvent for the diastereoselective protonations. Fortunately [12], we found no change in diastereoselectivity, when the HMPT was omitted. This is in sharp contrast to the protonation of the doubly deprotonated nitroaldols **28** (see above, *Section* **C** and *Table 2*), which takes place in a diastereoselective fashion only in the presence of a dipolar cosolvent. Of the ratios in *Scheme 6*, only the values for **20** and **22** are still from experiments with HMPT-cosolvent. The β-*O*-branched product **20** gave a rather poor deprotonation-protonation yield in the absence of HMPT.

[12]) This stability can also be a problem, see the discussion in *Section* **F**.

Scheme 7



36–38 39

	R^1	R^2	% *erythro*-Isomer a		% Recovery
			before deprotonation	after deprotonation	
36	C_3H_7	C_2H_5	34	93	78
37	C_5H_{11}	CH_3	50	91	90
38	C_6H_5	C_2H_5	25	83	85

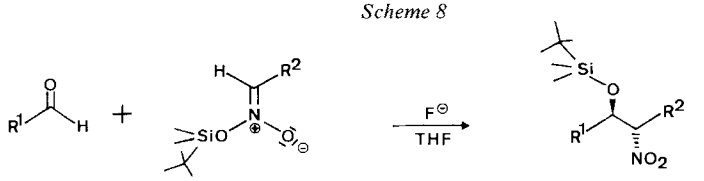
the recovery rates given in *Scheme 7*, the low temperature protonation of the nitronates **39** with acetic acid must be followed by a long warm-up period before the usual aqueous workup[13]). The TMSi-nitroaldols **36–38** are lower boiling and hence easier to distil without decomposition, and can be desilylated much more easily than the TBDMSi-analogues[12]).

E) *erythro-O*-(*t*-Butyl)dimethylsilyl-nitroaldols by fluoride-catalyzed silyl-nitroaldol addition *(Scheme 8).* – In our original work on the fluoride-catalyzed addition of silyl-nitronates to aldehydes [7], the silylated nitroaldol products obtained sometimes consisted of essentially one isomer. However, at that time we were not able to prepare diastereomerically enriched products reproducibly. As a result of accidental observations and extensive experimentation, we are now able to describe the conditions necessary for preparing *erythro*-silylnitroaldols such as **13–17**, **22**, **46**, **47** by direct C,C-bond formation in yields of about 60% from aldehydes and silyl nitronates **40–45** (s. *Scheme 8*). The following factors are important not so much for the actual reaction, but for its diastereoselectivity; *a)* the silyl nitronates **40–45** must be distilled, pure materials; for large scale preparations (>20 mmol) and distillations a nonaqueous workup under exclusion of air is recommended in addition to the precautions given previously [7] [14]; *b)* only the (*t*-butyl)dimethylsilyl *aci*-nitronates lead to *erythro*-nitroaldol derivatives, the trimethylsilyl analogues furnish mixtures in which neither the *erythro*- nor the *threo*-isomer prevails to any extent which would be considered useful for preparative purposes. This is true, even if the reaction is carried out at −100° (as shown in the case of the addition of the trimethylsilyl ester of 1-*aci*-nitropropane to propanal); *c)* of the many types of anhydrous fluoride which we have tested as catalysts, only tetrabutylammonium fluoride which was *freshly dried over molecular sieve* in a THF solution [15] caused the reaction to be reproducibly diastereoselective[14]). Commercial THF-solutions of Bu_4NF as purchased from *Aldrich*, heat-dried Bu_4NF (4 h, 90°/0.1 Torr [7] [16]),

[13]) In contrast to the TBDMSi-nitronates **35** and for reasons not known to us, the TMSi-nitronates **39** lead to substantial amounts of nitroolefins and/or desilylated nitroaldols in the isolated crude product, if the normal procedure, lacking the long warm-up period, is followed.

[14]) The 'universal brand', *Union Carbide* molecular sieve type 4 Å (as purchased for instance from *Fluka AG*, Buchs, or *Dr. Bender & Dr. Hobein*, Zürich) was employed, with or without stirring or filtering the THF solution prior to use.

Scheme 8



40–45 **13–17, 22, 46, 47**

	R^2 in Si-nitronate		%ds (*erythro*-form a)
40	CH_3	**13**	> 95
41	C_2H_5	**14**	> 95
42	(*S*)-$CH(CH_3)C_2H_5$	**15**	> 95
43	C_5H_{11}	**16**	> 95
44	C_7H_{15}	**17**	> 95
45	CH_2–CH_2–$COOCH_3$	**22**	78
		46 (R^1 = *m*-$OMeC_6H_4$, R^2 = C_2H_5)	80
		47 (R^1 = C_6H_5, R^2 = C_5H_{11})	85

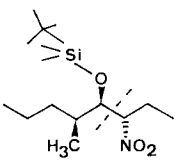
Bu_4NF adsorbed on Alumina [17], and polymer-bound[14]) fluoride effected the reaction at least to some extent, but caused less or no *erythro*-selectivity. A crystalline material obtained from potassium fluoride, [2.2.2]-cryptant, and chloroform [19] showed no catalytic activity with TBDMSi-*aci*-nitronates, but a very high one with the trimethylsilyl (TMSi) derivatives, which were added to aldehydes to give mixtures of diastereomers (*cf.* **36–38** in *Scheme 7*, and *b* above); *d)* the reaction mixture, which is prepared at dry-ice temperature and then allowed to warm-up, must not be kept at room temperature too long: the *erythro*-products formed might be epimerized by the fluoride catalyst[15]) or by other basic species which may be present in the reaction mixture. Normally, the silylnitroaldol reaction is over when the reaction mixture has reached a temperature of + 10° (for details see the *Exper. Part*); *e)* distillation of *erythro*-enriched *O*-TBDMSi-nitroaldol derivatives in the presence of non-silylated material (proton source?) may also lead to epimerization. Therefore, it may be advantageous to do a silylation (see below) before distillation, or to remove free alcohol by filtration over a short silicagel column with pentane/ether 9 : 1 as solvent[16]).

If the reaction conditions are carefully followed as described above and in *Experimental Part*, the *O*-silylated aliphatic derivatives **13–17** in *Scheme 8* are obtained as essentially pure *erythro*-isomers (< 5% *threo*-content by ^{13}C-NMR.), while the adducts **22**, **46** and **47** to aromatic aldehydes are formed with *ca.* 80% ds.

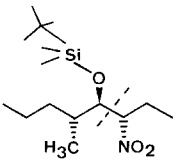
In order to test, whether our *erythro*-selective silylnitroaldol reaction obeys the *Cram*-rule (open-chain model) [20] or exhibits an asymmetric induction by an α-branching substituent in the nitronate component, we allowed the nitronate **41**

[15]) This is not surprising, since it is known that fluoride ion can catalyze nitroaldol reactions (see [117] in [1]). The rate of epimerization increases strongly on going from aliphatic derivatives **13–21**, **48–51**, to the aryl substituted compounds **22**, **46**, **47** to the γ-nitroesters **52–54**.

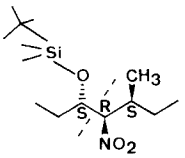
[16]) The crude products from the reactions of *Scheme 8* may contain variable amounts of free nitroaldol which can be easily detected and determined by NMR. spectroscopy. This is of course also possible with the products from silylation (**3–12** → **13–22**) and from deprotonation/protonation (*Scheme 6*).



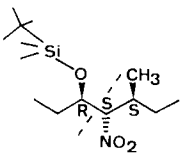
48



49



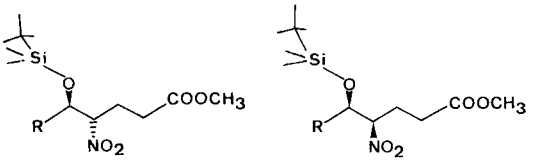
50



51

from nitropropane to react with (±)-2-methylpentanal and the nitronate **42** from (*S*)-2-methyl-1-nitrobutane with propanal, respectively. In both cases *four* diastereomers could possibly have been formed. However, we detected *two* diastereomers only, in a ratio of *ca.* 1:1. We assume that the relative configuration at the two newly formed asymmetric C-atoms (see the dotted lines in the *formulae* **48**–**51**) is *erythro* as in all other *O*-TBDMSi-nitroaldols listed in *Scheme 8;* this assignment is in agreement with the ^{13}C-NMR. shifts of the α-N- and α-O-C-atoms of the four compounds (*cf. Table 1* and *Section* **B**). Thus, the adduct **48** to α-methylvaleraldehyde which was formed following the *Cram*-rule and its epimer **49** should be the products[4]) from the first reaction, and the two enantiomerically pure diastereomers **50** and **51** should be those from the second reaction. Neither one of the two processes exhibits α-induction.

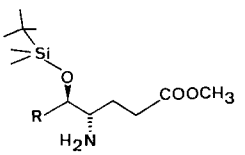
Scheme 9



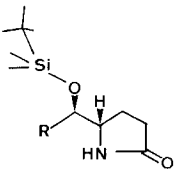
a **52–54** **b**

Compound	R	Reaction temp.	*erythro/threo*-Ratio (**a/b**)
52	C_2H_5	−20°	>98:2
		10°	84:16
		20°	~50:50
53	C_5H_{11}	10°	85:15
54	C_6H_5	3°	83:17
		10°	26:74

Products of Raney-*nickel reduction:*



55



56: R = C_2H_5 (87:13)
57: R = C_6H_5 (82:18)

In order to see, whether the *erythro*-diastereoselective, fluoride-catalyzed *O*-silylnitroaldol addition is compatible with other functional groups, we have carried out additions of the silylnitronate **45**, which is derived from methyl 4-nitrobutanoate, to three different aldehydes. It is evident from the results shown in *Scheme 9*, that the *O*-silylated nitroaldols **52–54** can be formed in high diastereoselectivity[17]), if the reaction temperature is kept low enough. *Raney*-nickel reductions of the nitro groups of **52** and **54** furnish mixtures of amines **55** and lactams (**56**, **57**). The amine portion of these mixtures cyclizes to lactam on heating, and the lactams isolated consist of a mixture of two diastereomers in about the same ratio as that of the starting nitroesters.

F) Discussion and conclusions. – Three independent routes to diastereomerically enriched nitroaldols or their *O*-silylated derivatives have been discovered: *i)* the protonation of doubly deprotonated nitroaldols **28**, leading to *threo*-products with highest diastereoselectivity in the case of nitroaldols from aromatic aldehydes (see *Scheme 5* and *Table 2*); *ii)* the protonation of *O*-silylated nitroaldol nitronates **35** and **39** which in the case of the TBDMSi-derivatives appears to give essentially

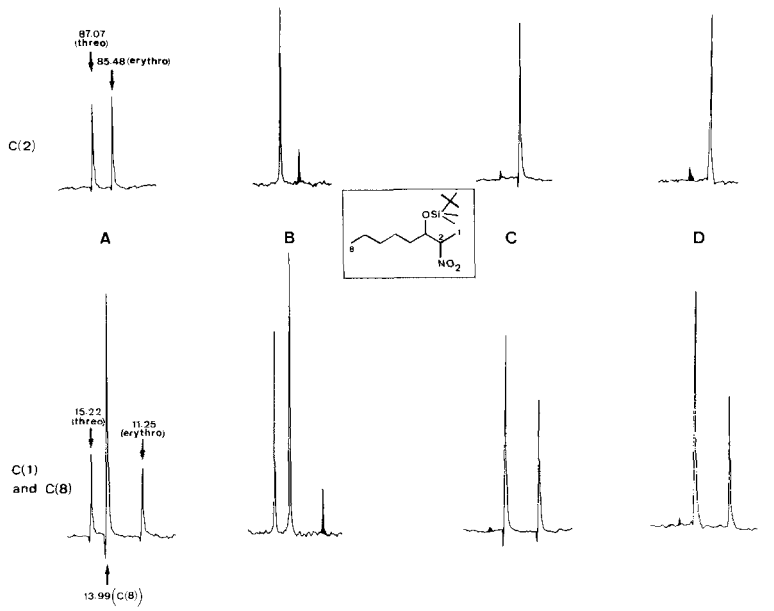
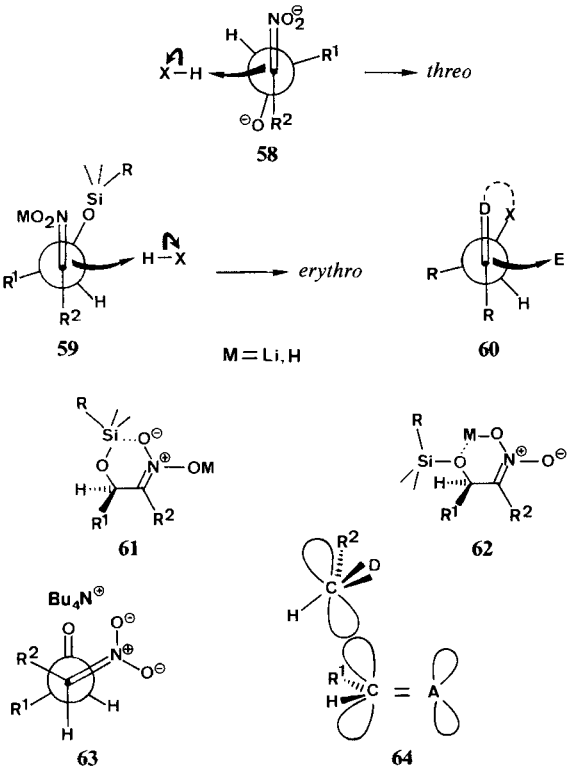


Fig. 1. *^{13}C-NMR. Spectra of 3-(t-butyl)dimethylsilyloxy-2-nitrooctane* (**15**) *obtained* via *different routes.* **A**: from classical *Henry* reaction followed by *O*-silylation; **B**: from low-temperature protonation of the dilithio derivative **28** ($R^1 = C_5H_{11}$, $R^2 = CH_3$) followed by *O*-silylation; **C**: from low-temperature protonation of the nitronate **35** ($R^1 = C_5H_{11}$, $R^2 = CH_3$) of *O*-silylated nitroaldol; **D**: from fluoride-catalyzed *O*-silylnitroaldol addition. The signals from the minor isomers are darkened for easy identification.

[17]) It turns out to be necessary to silylate the crude products from the reaction of the ester-containing nitronate **45** with TBDMSi-triflate/lutidine [21a] before distillation because free nitroaldol (present to < 10%) codistils with **52–54**. No epimerization occurs during this silylation procedure.

Scheme 10



pure *erythro*-products, unless a nitroaldol from an aromatic aldehyde is involved (see *Scheme 6*); *iii)* in striking similarity with the previous process, pure *erythro-O*-TBDMSi-nitroaldols are obtained from the fluoride-catalyzed *O*-silylnitroaldol additions between aliphatic components, while the addition to aromatic aldehydes exhibits only a *ca.* 80% diastereoselectivity (see *Scheme 8* and **48**–**51**). A comparison of the ^{13}C-NMR. spectra of the *O*-silylated nitroaldols **15** of different origins in *Figure 1* demonstrates the selectivities of the reactions mentioned under *i–iii*, in contrast to the classical *Henry* reaction.

It is tempting to make charge repulsion of the two negative charges of the doubly deprotonated nitroaldol responsible for the *threo*-selectivity of the protonation in the presence of dipolar cosolvents such as HMPT or DMPU (see the topological picture **58** of *Scheme 10*)[18]). The *erythro*-selective protonation of silyloxynitronates as outlined in **59** follows a quite general topological rule shown in **60** [2] [23] [24][19]). The lithium nitronate of the *O*-silylated nitroaldol is either protonated directly on carbon (see M = Li in **59**, **61**, and **62**), or – more likely – it is first protonated on oxygen to give a nitronic acid (M = H in **59**, **61**, and **62**) which

[18]) Resembling the dipolar model of the *Cram-Cornforth* rule for *α*-asymmetric inductions in additions to acceptor C=O-bonds [22].

[19]) *Cf.* the cyclic model of *Cram*'s rule [25] [26].

is subsequently tautomerized to the nitro compound. Finally, the *erythro*-selective C,C-bond formation in the fluoride-catalyzed *O*-silylnitroaldol reaction may be depicted as shown in **63** and follows a topological rule (see **64**) for joining two 2-dimensionally chiral stereogenic centers [27]. The mechanistic relevance of these models is uncertain: charge-controlled protonations should lead to *aci*-nitro derivatives (see for instance **59–62**, M = H), the protonations of which ought to establish the observed product configurations[20]).

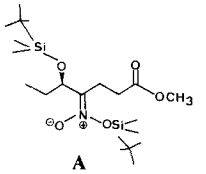
Also, our recent work on the structure and reactivity of lithium enolate aggregates [28] suggests that mechanistic details might be much more complicated than those derived from simple monomeric *formulae* such as **58**, **59**, **61** and **62** (M = Li). Further investigations will be necessary to elucidate mechanisms of these reactions.

Not surprisingly, the present establishment of conditions for carrying out the nitroaldol reaction in a diastereoselective manner, comes *after* the corresponding results concerning the simple aldol addition[21]) [29]: this is due to the much greater configurational lability of nitroaldols, as compared to aldols.

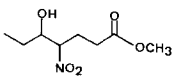
It is evident from several *Raney*-nickel reductions described in the *Experimental Part*[22]), that the diastereomeric enrichments of nitroaldols can be preserved in the corresponding aminoalcohol derivatives under carefully controlled neutral conditions. Since there are methods known by which diastereomeric 2-amino-alcohols can be interconverted [31], it is feasible, at least in principle, to convert the *erythro*-aminoalcohols, more readily available by the present methods, to *threo*-isomers. The desilylation[12]) of *O*-TBDMSi-aminoalcohols from the *Raney*-nickel reductions can present significant problems. Since Bu_4NF gave only low yields of free aminoalcohols which were difficult to separate from the ammonium salt-containing reaction mixtures, the use of aqueous HF-solutions was investigated also with little success. The observation that the α-N-epimerizing LAH-reduction produced free aminoalcohols [7] (see *Scheme 11*) suggested[23]), that a desilylation of *O*-silyl-aminoalcohols could be achieved with LAH in ether. This has in fact been realized: the 3-amino-4-nonanol (**65**) was obtained (87%) by LAH-reduction of the TBDMSi-ether (prepared by *Raney*-nickel reduction of **16**) in refluxing di-

---

[20]) Actually, in the reaction between the nitrobutanoate-derived *O*-silylnitronate **45** with propanol, low-temperature quenching leads to the isolation of a mixture of the doubly silylated nitronate **A** and the free nitroaldol **B**. If, however, the reaction mixture is warmed to + 10°, the *ca.* 85% *erythro*-enriched sample of **52** is obtained as shown in *Scheme 9*.



A



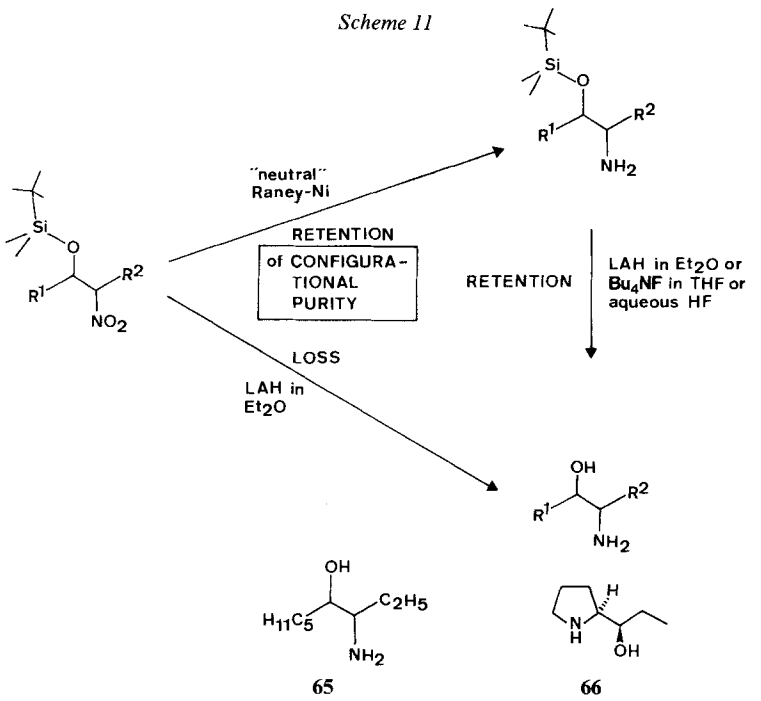
B

[21]) For the most recent comprehensive and authoritative rewiew articles by *Heathcock* and by *Evans et al.*, see [30].

[22]) These hydrogenations are described as part of the characterization of the corresponding nitro compounds; *cf.* also *footnote 6* and **56**, **57**.

[23]) Since free nitroaldols undergo complete C,C-bond cleavage with LAH (retroaldol followed by reduction of the resulting aldehyde and nitroalkane [7] [32]), the LAH-desilylation of *Scheme 11* has to take place *after* the reduction of the nitro group.

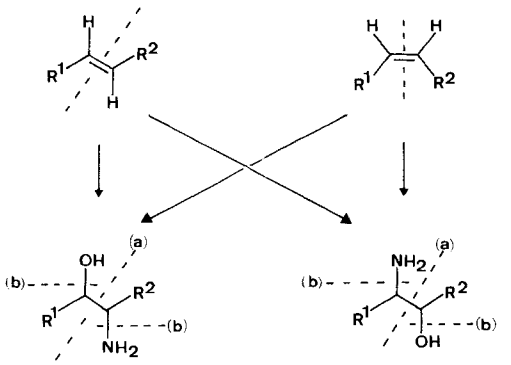
Scheme 11



ethyl ether. Reduction of the lactam (**56**) under very similar conditions furnished 2-(1′-hydroxy-1′-propyl)pyrrolidine (**66**) again in high yield (86%)[24]. The stereochemical integrities of the silyloxy amino compounds were maintained during the reduction to the aminoalcohols.

The diastereoselective nitroaldol addition followed by hydrogenation of the nitro group is a *connective* synthesis of aminoalcohols, which can be considered as a combination of a hydroxyalkyl-a^1 with an aminoalkyl-d^1 reagent [see (a) in

Scheme 12



[24]) This observation is interesting also because the (*t*-butyl)dimethylsilyl group has been reported to be stable under mild chemical reduction conditions [21b].

Scheme 12]. Other aminoalkyl-d[1] reagents such as lithiated nitrosamines [9b] [33], metallated amides [34], phosphoramides [35], ureas [36], urethanes [37], amidines [38], α-cyanobenzamides [39], and enolates of α-aminoacid derivatives [40] do not add to aldehydes in a highly stereoselective fashion – or have not been investigated as yet in this regard! Finally, it should be pointed out, that diastereoselective aminohydroxylations of (*E*)- or (*Z*)-olefins [see (b) in *Scheme 12*][25]) are not expected to be regioselective, while any one of the two constitutionally isomeric aminoalcohols shown in *Scheme 12* is available from the corresponding nitroalkanes and aldehydes by the present method.

We thank Dr. *Th. Weller*, Dr. *F. Lehr*, Miss *D. Leuthard* and Miss *G. Winteler* for some preliminary experiments. The financial support by the *Sandoz AG* (Basel) is gratefully acknowledged. Thanks are also due to *Hoechst AG* (Frankfurt-Hoechst), *Chemische Fabrik Kalk GmbH* (Köln) and Dr. *H. Braunschweiger (Sandoz AG)* for the generous supply of solvents, bromoalkanes and methyl 4-nitrobutanoate, respectively. We appreciate the valuable help by *F. Bangerter*, *B. Brandenberg*, *R. Hässig* and *K. Hiltbrunner* (NMR. spectra) and *D. Manser* (elemental analyses). *T.M.* thanks the *Sandoz AG* (Basel) for a postdoctoral stipend, *E.T.* greatfully acknowledges receipt of a postdoctoral fellowship from the *Royal Society of London.*

Experimental Part

1. General remarks. – Tetrahydrofuran (THF) was purified by distillation from either $LiAlH_4$ (LAH) or potassium-benzophenone. Diisopropylamine was distilled over CaH_2. Hexamethylphosphoric triamide (HMPT) and *N,N'*-dimethyl-*N,N'*-propylene urea (DMPU) were vacuum distilled over CaH_2. Butyllithium (BuLi) in hexane (*Metallgesellschaft AG*) was standardized using the diphenylacetic acid method [41]. All the reactions were carried out in a dry Ar-atmosphere. All the glassware was dried overnight at 140°. Capillary GC.: *Carlo Erba HRGC* Fractovap series *4160* using *CW-1000* column (22 m × 0.3 mm). Bulb-to-bulb distillations were carried out using *Büchi GKR-50* and *Chemophor* Custilator, depending on the scale, and boiling points (b.p.) refer to air bath temperatures. For column chromatography, *Merck* silica gel 60 (70–230 Mesh) was used. During chromatographic purification of silylated nitroaldols different fractions showed enrichment of one of the two diastereomers – hence all fractions must be combined for estimation of diastereomeric ratios. Melting points (m.p.) were determined using a *Büchi 510* apparatus. All m.p. and b.p. are uncorrected. The following instruments were used: for IR. *Perkin-Elmer 297*-Spectrophotometer (data in cm^{-1}; all IR. spectra were recorded as films unless otherwise mentioned); for ^{1}H-NMR.: *Varian EM-390* (90 MHz) and *Bruker WM 300-WB* (300 MHz) (unless otherwise indicated the reported spectra were recorded at 90 MHz; chemical shifts are given in parts per million (ppm) with internal $CHCl_3$ signal at 7.28 ppm as the reference standard in the case of silylated compounds and tetramethylsilane (TMS) signal at 0.0 ppm in all other cases; multiplicities as *s* (singlet), *d* (doublet), *t* (triplet), *qa* (quadruplet), *qi* (quintuplet), *sept* (septuplet), *m* (multiplet); coupling constants (*J*) in Hz); for ^{13}C-NMR. *Varian CFT-20, XL-100* and *Bruker WM300-WB* (chemical shifts in ppm with the central $CDCl_3$ signal at 77.0 ppm or central C_6D_6-signal at 128.0 ppm as the internal standard). Ratio of the diastereomers, determined by ^{13}C-NMR., represent the ratio of the peak heights (p.h.) or the integration of ^{13}C-N-signal and is indicated accordingly after the ratios.

2. Starting Materials. – *Methyl 4-nitrobutanoate* [3] [42], *2-methyl-1-nitropropane* [43], and *1-nitrooctane* [44] were prepared according to the published procedures. All other racemic compounds were purchased from commercial sources.

Preparation of (–)-(S)-2-methyl-1-nitrobutane. Preparation of (+)-(S)-(2-methyl)butyl p-*toluenesulfonate.* Dry triethylamine (60 ml, 0.43 mol) was added dropwise to a magnetically stirred solution of *p*-toluenesulfonyl chloride (41.5 g, 0.218 mol) and (*S*)-2-methylbutanol (16.03 g, 0.182 mol), obtained free from 3-methylbutanol by careful distillation through a spinning-band column, in dry CH_2Cl_2

[25]) Such as those which led to **23a** and **23b** from 3-hexene (see *Section* **B**).

(150 ml) which was cooled in an ice/salt bath. After the addition was complete, the mixture was stirred at 0° for 1 h and at 20° for 3 h. Water (50 ml) was added and the mixture stirred for a further 1 h. The aqueous layer was separated and extracted with CH_2Cl_2. The combined extracts were washed with water, sat. aq. NaCl-solution, dried ($MgSO_4$) and evaporated. The crude product (43.9 g) was bulb-to-bulb distilled in three portions (a small amount of solid $NaHCO_3$ being added prior to distillation) to obtain the toluenesulfonate (39.8 g, 91%) as a colorless liquid, b.p. 160°/0.04 Torr, $[\alpha]_D^{25} = +3.9°$ (neat liquid) ([45]: b.p. 136–139°/0.01 Torr, $[\alpha]_D = +3.75°$). – ^{1}H-NMR. ($CDCl_3$): 0.7–2.0 (*m*, 9 H, 3 H–C(4), H_3C–C(2), 2 H–C(3) and H–C(2)); 2.43 (*s*, 3 H, CH_3); 3.86 (*d*, $J = 6$, 2 H, 2 H–C(1)); 7.4 (*d*, $J = 9$, 2 H, arom. H); 7.83 (*d*, $J = 9$, 2 H, arom. H).

Preparation of (+)-(S)-1-iodo-2-methylbutane. To a stirred ice-cooled suspension of magnesium turnings (5.4 g, 225 at-equiv.) in anh. ether (500 ml) under Ar was added I_2 (38 g, 150 mmol) in small portions. At the end of the addition, the mixture was stirred at 20° for 1 h during which time the brown color disappeared. The MgI_2-solution thus prepared was transferred *via* teflon tubing to an Ar-frit and thus filtered into a stirred solution of (+)-(*S*)-(2-methyl)butyl *p*-toluenesulfonate (18 g, 74.5 mmol) in anh. ether (30 ml). When the addition was complete the mixture was stirred at 20° for 12 h. Water was added and the mixture extracted with ether. The extracts were washed with water, sat. aq. $NaHCO_3$- and aq. $Na_2S_2O_3$-solution, water and sat. aq. NaCl-solution. After drying ($MgSO_4$), the ether was distilled off at atmospheric pressure and the residue was distilled at reduced pressure to give the iodide (10.51 g, 71%), b.p. 50°/23 Torr, $[\alpha]_D^{25} = +5.86°$ (neat liquid) ([46]: $[\alpha]_D^{23} = +4.8°$ (neat liquid)). – ^{1}H-NMR. ($CDCl_3$): 0.8–1.85 (*m*, 9 H, 3 H–C(4), H_3C–C(2), 2 H–C(3) and H–C(2)); 3.2 (*d*, $J = 4.5$, 2 H, H_2C(1)).

Preparation of (–)-(S)-2-methyl-1-nitrobutane. A stirred suspension of silver nitrite (10.4 g, 67 mmol) in anh. ether (50 ml) was cooled (ice/salt bath) and (*S*)-1-iodo-2-methylbutane (10.3 g, 52 mmol) added dropwise. The mixture was subsequently stirred at 0° for 24 h and at 20° for a further 48 h. It was then filtered through *Celite* and the filtrate evaporated. The residue was purified by fractional distillation to give the nitro compound (3.8 g, 62%), b.p. 73°/30 Torr, $[\alpha]_D^{25} = -7.18°$ (neat liquid). – IR.: 2970, 1550, 1370. – ^{1}H-NMR. ($CDCl_3$): 0.8–1.1 (*m*, 6 H, 3 H–C(4) and H_3C–C(2)); 1.16–1.63 (*m*, 2 H, 2 H–C(3)); 2.03–2.46 (*m*, 1 H, H–C(2)); 4.25 (two *d* × *d*, $J = 6.5$ and 10.5, 7.5 and 11.0, 2 H, H_2C(1)).

3. *Raney*-nickel reduction of nitro compounds to amino compounds. – *General procedure I* (GP I). Nickel/aluminium alloy (20 g) in water (200 ml) was treated with NaOH (32 g) in small portions. The mixture was heated to 70° for 30 min. After cooling to 20° the aqueous phase was decanted and the *Raney*-nickel was washed with distilled water until completely neutral, and then with ethanol (5 times). The freshly prepared *Raney*-nickel, the freshly distilled nitro compound (30 mmol) and ethanol (250 ml) were shaken in a steel autoclave under 25 atm. H_2 for 20 h at 50°. The mixture was filtered through *Celite* and the filtrate evaporated to give the crude amino compound which was purified by bulb-to-bulb distillation.

General procedure II (GP II). To a solution of NaOH (17.1 g) in water (69 ml) were added nickel/aluminium alloy (13.5 g) in small lots maintaining the temperature below 30° (cooling in an ice-bath). After the completion of addition the suspension was heated at 70° until the H_2-evolution had practically stopped. The residual black solid was washed with distilled water (13 × 300 ml) until the pH of the supernatant liquid was same as that of distilled water, followed by additional washing (6 × 300 ml) to ensure neutrality of the catalyst. The residue was then washed with abs. methanol (3 × 200 ml). A slurry of the catalyst in abs. methanol (40 ml) was added to the nitro compound (4.2 mmol) and the suspension was stirred at r.t. in a H_2-atmosphere for 20 h. Ether (100 ml) was added and after the catalyst had settled the supernatant liquid was carefully decanted. The solvent was then distilled off in a rotatory evaporator to obtain the crude product which was further processed as described in individual cases.

4. Preparation of nitroaldols [8]. – *General procedure.* To a stirred mixture of the nitroalkane (0.2 mol), ethanol (7.8 ml) and 10N aq. NaOH (0.39 ml) was added the freshly distilled aldehyde (0.2 mol), the temp. being maintained between 30° and 35°. After approximately two thirds of the aldehyde had been added, more 10N aq. NaOH (0.39 ml) and water (1.5 ml) were added, and the aldehyde addition was continued. The mixture was stirred at 38° for 65 h and was then treated with aq. 2N HCl (*ca.* 4 ml) to pH 7. It was extracted with hexane and the extracts washed with water (3 × 50 ml) and sat. aq. NaCl-solution, dried ($MgSO_4$) and evaporated to give the crude nitroaldol which was purified by bulb-to-bulb distillation.

Data of 4-nitro-3-hexanol (**3**). Yield 80%, b.p. 48–50°/0.15 Torr. – IR.: 3440 (OH), 2970, 1550 (NO_2). – ^{1}H-NMR. ($CDCl_3$): 0.85–1.15 (*m*, 6 H, 3 H–C(1) and 3 H–C(2)); 1.3–2.25 (*m*, 4 H, 2 H–C(2) and 2 H–C(5)); 2.4 (br. *s*, 1 H, OH); 3.7–4.06 (*m*, 1 H, H–C(3)); 4.26–4.55 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. ($CDCl_3$): 94.08 (C(4), *threo*); 93.35 (C(4), *erythro*); 72.99 (C(3), *erythro*); 72.67 (C(3), *threo*); 25.53, 25.44, 22.88, 21.42, 9.60, 9.32, 9.15 and 8.68. *threo/erythro* = 1.7:1 (integration).

Data of 3-nitro-4-heptanol (**4**). Yield 63%, b.p. 83–85°/2 Torr ([47]: b.p. 122–123°/18 Torr). – ^{1}H-NMR. (CCl_4): 0.6–1.1 (*m*, 6 H, 3 H–C(1) and 3 H–C(7)); 1.1–2.35 (*m*, 6 H, 2 H–C(2), 2 H–C(5) and 2 H–C(6)); 2.75 (br. *s*, 1 H, OH); 3.60–4.05 (*m*, 1 H); 4.05–4.45 (*m*, 1 H). – ^{13}C-NMR. ($CDCl_3$): 94.44 (C(3), *threo*); 94.02 (C(3), *erythro*); 72.08 (C(4) *erythro*); 71.63 (C(4), *threo*); 35.72, 35.42, 23.93, 21.62, 18.90, 18.59, 13.80, 10.55 and 10.20. *threo/erythro* = 1.9: 1(p.h.).

Data of 2-nitro-3-octanol (**5**). Yield 52%, b.p. 100–110°/2 Torr ([47]: b.p. 133–134°/22 Torr). – ^{1}H-NMR. (CCl_4): 0.8–1.1 (*m*, 3 H, 3 H–C(8)), 1.1–1.65 (*m*, 11 H, 3 H–C(1), 2 H–C(4), 2 H–C(5), 2 H–C(6) and 2 H–C(7)); 2.9 (br. *s*, 1 H, OH); 3.7–4.25 (*m*, 1 H); 4.25–4.65 (*m*, 1 H). – ^{13}C-NMR. ($CDCl_3$): 87.59 (C(2), *threo*); 86.22 (C(2), *erythro*); 72.60 (C(3), *threo*); 72.15 (C(3), *erythro*); 32.89, 32.36, 31.19, 24.99, 24.41, 22.10, 15.42, 13.46 and 12.00. *threo/erythro* = 1.2:1 (p.h.).

Data of 3-nitro-4-nonanol (**6**). Yield 58%, b.p. 100–110°/3 Torr, n_D^{25} = 1.4492 ([48]: b.p. 108°/2 Torr, n_D^{25} = 1.4500). – IR.: 3440 (OH), 1550 (NO_2), 1380 (NO_2). – ^{1}H-NMR. (CCl_4): 0.7–1.1 (*m*, 6 H, 3 H–C(1) and 3 H–C(9)); 1.1–1.7 (*m*, 8 H, 2 H–C(5), 2 H–C(6), 2 H–C(7) and 2 H–C(8)); 1.7–2.4 (*m*, 2 H, 2 H–C(2)); 2.4–2.9 (br. *s*, 1 H, OH); 3.6–4.0 (*m*, 1 H); 4.0–4.4 (*m*, 1 H). – ^{13}C-NMR. ($CDCl_3$): 94.47 (C(3), *threo*); 93.92 (C(3), *erythro*); 72.05 (C(4), *erythro*); 71.71 (C(4), *threo*); 33.03, 31.32, 24.98, 24.59, 23.38, 22.20, 21.67, 13.56, 10.09 and 9.80; *threo/erythro* = 1.4:1 (p.h.).

Reduction of **6** (GP I) gave *3-amino-4-nonanol.* Yield 83%, b.p. 65–70°/0.03 Torr. – IR.: 3350, 1460. – ^{1}H-NMR. ($CDCl_3$): 0.8–1.15 (2 overlapping *t*, 6 H, 3 H–C(1) and 3 H–C(9)); 1.15–1.7 (*m*, 10 H, 2 H–C(2), 2 H–C(5), 2 H–C(6), 2 H–C(7) and 2 H–C(8)); 2.2 (*s*, 3 H, OH and NH_2); 2.3–2.8 (*m*, 1 H, H–C(3)); 3.2–3.5 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. (C_6D_6): 73.76 (C(4)); 73.36 (C(4)); 57.94 (C(3)); 57.64 (C(3)); 34.69, 32.55, 32.43, 26.58, 26.15, 24.63, 23.17, 14.33 and 10.81.

Data of 5-nitro-4-dodecanol (**7**). Yield 30%, b.p. 140–145°/1 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.7–1.1 (*m*, 6 H, 3 H–C(1) and 3 H–C(12)); 1.1–2.3 (*m*, 16 H, 8 CH_2); 3.4–3.75 (br. *s*, 1 H, OH); 3.75–4.15 (*m*, 1 H, H–C(4)); 4.3–4.65 (*m*, 1 H, H–C(5)). – ^{13}C-NMR. ($CDCl_3$): 93.03 (C(5), *threo*); 92.40 (C(5), *erythro*); 71.98 (C(4), *erythro*); 71.70 (C(4), *threo*); 35.19, 35.04, 31.42, 30.00, 28.66, 28.18, 25.77, 25.49, 22.27, 18.55, 18.21, 13.63 and 13.43. *threo/erythro* = 3.3:1 (p.h.).

$C_{12}H_{25}NO_3$(213.33) Calc. C 62.30 H 10.89 N 6.05% Found C 62.48 H 11.01 N 5.89%

Reduction (GP I) *of* **7** furnished *5-amino-4-dodecanol.* Yield 85%, b.p. 95–105°/0.04 Torr. – IR.: 3300, 1460. – ^{1}H-NMR. ($CDCl_3$): 0.7–1.1 (*m*, 6 H, 3 H–C(1) and 3 H–C(12)); 1.1–1.6 (*m*, 16 H, 8 CH_2); 2.1 (br. *s*, 3 H, OH and NH_2); 2.4–2.75 (*m*, 1 H, H–C(5)); 3.1–3.55 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. (C_6D_6): 73.50 (C(4)); 73.32 (C(4)); 56.44 (C(5)); 56.32 (C(5)); 37.04, 32.40, 32.30, 30.39, 29.85, 27.87, 27,17, 23.11, 20.04, 19.60, 14.53 and 14.33.

Data of 2-nitro-3-tridecanol (**8**). Yield 61%, b.p. 130°/1 Torr ([8]: b.p. 153–155°/2 Torr). – ^{1}H-NMR. (CCl_4): 0.75–1.05 (*m*, 3 H, 3 H–C(13)); 1.05–1.65 (*m*, 22 H, 3 H–C(1), HO and 9 CH_2); 3.65–4.2 (*m*, 1 H); 4.2–4.65 (*m*, 1 H). – ^{13}C-NMR. ($CDCl_3$): 87.69 (C(2), *threo*); 86.38 (C(2), *erythro*); 72.84 (C(3), *erythro*); 72.20 (C(3), *threo*); 33.11, 32.77, 31.78, 29.44, 29.37, 29.20, 25.60, 25.02, 22.51, 15.78, 13.86 and 12.21. *threo/erythro* = 1.4:1 (p.h.).

Reduction (GP I) *of* **8** gave *2-amino-3-tridecanol.* Yield 39%, m.p. 34–35°. – IR. ($CHCl_3$): 3350, 1460. – ^{1}H-NMR. ($CDCl_3$): 0.7–1.6 (*m*, 24 H, 3 H–C(1), 3 H–C(13) and 9 CH_2); 1.8 (br. *s*, 3 H, OH and NH_2); 2.6–3.1 (*m*, 1 H, H–C(2)); 3.1–3.6 (*m*, 1 H, H–C(3)). – ^{13}C-NMR. (C_6D_6): 75.73 (C(3)); 74.56 (C(3)); 51.81 (C(2)); 51.34 (C(2)); 34.66, 33.47, 32.33, 30.42, 30.25, 30.14, 29.83, 26.98, 26.47, 23.08, 20.51, 17.56 and 14.31.

Data of 7-nitro-6-tetradecanol (**9**). Yield 70%, b.p. 145–150°/1 Torr. – IR.: 3450 (OH), 1550 (NO_2). – ^{1}H-NMR. (CCl_4): 0.6–1.0 (*m*, 6 H, 3 H–C(1) and 3 H–C(14)); 1.05–2.5 (*m*, 21 H, OH and 10 CH_2); 3.5–4.0 (*m*, 1 H); 4.15–4.45 (*m*, 1 H). – ^{13}C-NMR. ($CDCl_3$): 93.04 (C(7), *threo*); 92.47 (C(7), *erythro*); 72.45 (C(6), *erythro*); 72.11 (C(6), *threo*); 33.46, 33.19, 31.57, 30.36, 28.87, 28.14, 25.98, 25.68, 25.24, 24.90, 22.48 and 13.89. *threo/erythro* = 1.1:1 (p.h.)

$C_{14}H_{29}NO_3$(259.39) Calc. C 64.83 H 11.27 N 5.40% Found C 64.84 H 11.32 N 5.40%

Data of 2-methyl-4-nitro-3-hexanol (**10**). Yield 54%, b.p. 70–71°/2 Torr ([48]: b.p. 78°/2 Torr). – ^{1}H-NMR. (CCl_4): 0.8–1.1 (*m*, 9 H, 3 H–C(1), 3 H–C–C(2) and 3 H–C(6)); 1.35–2.15 (*m*, 3 H, H–C(2) and 2 H–C(5)); 2.25 (br. *s*, 1 H, OH); 3.5 (*d*×*d* after exchange with D_2O, J = 6 and 6, 0.7 H, H–C(3), *threo*); 3.65 (*d*×*d*, J = 5.5 and 5.5, 0.3 H, H–C(3), *erythro*); 4.2–4.55 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. ($CDCl_3$): 92.57 (C(4), *threo*); 92.01 (C(4), *erythro*); 77.08 (C(3), *erythro*); 76.49 (C(3), *threo*); 30.53, 24.05, 21.77, 19.71, 19.26, 17.18, 16.28, 10.51 and 10.20. *threo/erythro* = 1.9:1 (p.h.).

$C_7H_{15}NO_3$(161.20) Calc. C 52.15 H 9.38 N 8.69% Found C 52.78 H 9.56 N 8.60%

Data of 2-methyl-3-nitro-4-heptanol (**11**). Yield 15%, b.p. 95–100°/7 Torr. – IR.: 3440 (OH), 1550 (NO_2), 1375 (NO_2). – ^{1}H-NMR. ($CDCl_3$): 0.8–1.25 (*m*, 9 H, 3 H–C(1), 3 H–C–C(2) and 3 H–C(7)); 1.25–1.85 (*m*, 4 H, 2 H–C(5) and 2 H–C(6)); 2.1–2.7 (*m*, 2 H, H–C(2) and OH); 3.8–4.5 (*m*, 2 H, H–C(3) and H–C(4)).

Data of 2-nitro-1-phenyl-1-butanol (**12**). Yield 26%, b.p. 120–125°/1 Torr ([5]: b.p. 120°/0.005 Torr). – ^{1}H-NMR. (CCl_4): 0.7–1.0 (*m*, 3 H, 3 H–C(4)); 1.0–2.1 (*m*, 2 H, 2 H–C(3)); 2.65 (br. *s*, 1 H, OH); 4.25–4.6 (*m*, 1 H, H–C(2)); 4.90 (*d*, J = 9, 0.75 H, H–C(1), *threo*); 5.05 (*d*, J = 6, 0.25 H, H–C(1), *erythro*); 7.3 (*s*, 5 H, arom. H). *threo/erythro* = 3:1. – ^{13}C-NMR. ($CDCl_3$): 138.69, 128.91, 128.84, 128.53, 126.83, 126.20, 95.19 (C(2), *threo*); 94.59 (C(2), *erythro*); 75.34 (C(1), *threo*); 74.20 (C(1), *erythro*); 23.76, 21.56, 10.17 and 9.85.

Reduction (GP I) *of* **12** furnished *2-amino-1-phenyl-1-butanol.* Yield 26%, b.p. 50–55°/0.01 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.7–1.0 (2 overlapping *t*, 3 H, 3 H–C(4)); 1.0–1.6 (*m*, 2 H, 2 H–C(3)); 2.4–2.8 (*m*, 4 H, H–C(2), NH_2 and OH); 4.25 (*d*, J = 6, 0.75 H, *threo*) and 4.45 (*d*, J = 4.5, 0.25 H, *erythro*) (H–C(1)); 7.3 (*s*, 5 H, arom. H). *threo/erythro* = 3:1.

5. Silylation of nitroaldols. –*General procedure III* (GP III) *(using (t-butyl)dimethylsilyl chloride or trimethylsilyl chloride).* A mixture of the nitroaldol (40 mmol), (*t*-butyl)dimethylsilyl chloride or trimethylsilyl chloride (48 mmol), imidazole (100 mmol) and DMF (10 ml) was stirred at 20° for 12 h. Water was added and the mixture extracted with hexane. The extracts were washed with water, sat. aq. NaCl-solution, and dried ($MgSO_4$). Evaporation gave the *O*-silylnitroaldol as an oil which was then bulb-to-bulb distilled. If an impurity of unreacted starting material was present in the distillate, this could be removed by chromatography over silica gel (30 g/1 g of the product) with 10% ether in pentane as eluant.

General procedure IV (GP IV) *(using (t-butyl)dimethylsilyl triflate* [21a]*).* To a cold (0°) solution of the nitro compound (5.7 mmol) in CH_2Cl_2 (20 ml) was added (*t*-butyl)dimethylsilyl triflate (1.8 ml, 8.1 mmol) followed by 2,6-lutidine (1.2 ml, 10.3 mmol). The mixture was stirred between 0–1° for 1 h and poured into a mixture of ether (80 ml) and water (20 ml). The aqueous layer was discarded and the organic phase was washed with water (3×50 ml), dil. HCl-solution (2×30 ml) followed by water (3×50 ml), dried ($MgSO_4$) and stripped of solvent in a rotary evaporator. The crude product was purified by bulb-to-bulb distillation.

Data of 3-(t-butyl)dimethylsilyloxy-4-nitrohexane (**13**). GP III, yield 66%, b.p. 79°/0.2 Torr. – IR.: 1550 (NO_2), 1460, 1255, 840. – ^{1}H-NMR. ($CDCl_3$): 0.00 and 0.03 (2 *s*, 6 H, $(H_3C)_2Si$); 0.7–1.03 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(1) and 3 H–C(6)); 1.3–2.2 (*m*, 4 H, 2 H–C(2) and 2 H–C(5)); 3.9–4.2 (*m*, 1 H, H–C(3)); 4.2–4.6 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. ($CDCl_3$): 93.73 (C(4), *threo*); 92.63 (C(4), *erythro*); 74.22 (C(3), *erythro*); 73.42 (C(3), *threo*); 26.65, 25.49, 22.79, 21.59, 17.84, 17.71, 10.57, 10.22, 8.72, 7.02, –4.67, –5.07, –5.67 and –5.79. *threo/erythro* = 2.2:1 (integration).

$C_{12}H_{27}NO_3Si$(261.44) Calc. C 55.13 H 10.41 N 5.36% Found C 55.15 H 10.34 N 5.24%

Reduction (GP I) *of* **13** gave *2-(t-butyl)dimethylsilyloxy-1-ethyl-butylamine* (**23**). Yield 79%, b.p. 125°/0.2 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.02 (*s*, 6 H, $(H_3C)_2Si$), 0.72–1.03 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(2′) and 3 H–C(4)); 1.1–1.75 (*m*, 6 H, NH_2, 2 H–C(1′) and 2 H–C(3)); 2.35–2.75 (*m*, 1 H, H–C(1)); 3.3–3.6 (*m*, 1 H, H–C(2)). – ^{13}C-NMR. ($CDCl_3$): 76.35 (C(2), *erythro*); 75.75 (C(2), *threo*), 56.47 (C(1), *erythro*), 54.59 (C(1), *threo*), 26.28, 25.56, 25.21, 24.85, 22.84, 17.38, 10.44, 9.64, 8.94, –4.87, –5.14 and –5.25. *threo/erythro* = 1.8:1 (integration).

Data of 4-(t-butyl)dimethylsilyloxy-3-nitroheptane (**14**). GP III, yield 78%, b.p. 60–75°/0.01 Torr. – IR.: 1555 (NO_2), 1260, 840. – ^{1}H-NMR. ($CDCl_3$): –0.05 and –0.03 (2 *s*, 6 H, $(H_3C)_2Si$); 0.65–1.05

(*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(1) and 3 H–C(7)); 1.05–2.2 (*m*, 6 H, 2 H–C(2), 2 H–C(5) and 2 H–C(6)); 3.85–4.15 (*m*, 1 H, H–C(4)); 4.15–4.55 (*m*, 1 H, H–C(3)). – ^{13}C-NMR. ($CDCl_3$): 94.23 (C(3), *threo*); 93.35 (C(3), *erythro*); 73.36 (C(4), *erythro*); 73.08 (C(4), *threo*); 36.37, 35.40, 26.07, 25.64, 25.17, 22.80, 21.58, 17.97, 16.56, 14.21, 14.03, 10.70, 10.38, –3.19, –4.74, –5.09 and –5.63. *threo/erythro* = 2.5:1 (p.h.).

$C_{13}H_{29}NO_3Si$(275.46) Calc. C 56.68 H 10.61 N 5.08% Found C 56.78 H 10.50 N 5.11%

Chromatographic purification of the sample on silica gel gave a fraction enriched in the *threo* isomer: *threo/erythro* = 6.8:1 (^{13}C-NMR., p.h.).

The enriched sample was reduced (GP I) to obtain *4-(t-butyl)dimethylsilyloxy-1-ethyl-pentylamine.* Yield 86%, b.p. 50°/0.03 Torr. – ^{1}H-NMR. (CCl_4): 0.0 (*s*, 6 H, $(H_3C)_2Si$); 0.7–1.0 (overlapping 2 *t* and *s*, 15 H, $(H_3C)_3CSi$, 3 H–C(2′) and 3 H–C(5)); 1.1–1.7 (*m*, 8 H, 2 H–C(1′), 2 H–C(3), 2 H–C(4) and NH_2); 2.3–2.7 (*m*, 1 H); 3.4–3.6 (*m*, 0.83 H) and 3.8–4.0 (*m*, 0.17 H). *threo/erythro* = 5:1.– ^{13}C-NMR. ($CDCl_3$): 75.50 (C(2)); 57.68 (C(1)); 33.07, 25.96, 25.78, 19.12, 18.14, 14.32 and 11.23. No $(H_3C)_2Si$-signal on scale.

Data of 3-(t-butyl)dimethylsilyloxy-2-nitrooctane (**15**). GP III, yield 65%, b.p. 100°/0.01 Torr. – IR.: 1550 (NO_2), 1260, 840, 780. – ^{1}H-NMR. ($CDCl_3$): –0.01, 0.03 and 0.05 (3 *s*, 6 H, $(H_3C)_2Si$); 0.7–1.0 (*m*, 12 H, $(H_3C)_3CSi$ and 3 H–C(8)); 1.0–1.65 (*m*, 11 H, 3 H–C(1), 2 H–C(4), 2 H–C(5), 2 H–C(6) and 2 H–C(7)); 3.8–4.75 (*m*, 2 H, H–C(3) and H–C(2)). – ^{13}C-NMR. ($CDCl_3$): 87.07 (C(2), *threo*); 85.48 (C(2), *erythro*); 73.85 (C(3)); 34.80, 32.75, 32.12, 31.87, 25.76, 25.01, 22.97, 22.62, 18.05, 15.22, 13.99, 11.25, –4.45, –5.12 and –5.31. *threo/erythro* = 1:1 (integration).

$C_{14}H_{31}NO_3Si$(289.48) Calc. C 58.08 H 10.80 N 4.84% Found C 58.20 H 10.86 N 4.85%

Data of 4-(t-butyl)dimethylsilyloxy-3-nitrononane (**16**). GP III; yield 85%, b.p. 110°/0.01 Torr. – IR.: 1550 (NO_2), 1255, 840, 780. – ^{1}H-NMR. ($CDCl_3$): 0.00 and 0.2 (2 *s*, 6 H, $(H_3C)_2Si$); 0.7–1.1 (*m*, 15 H, $H_3C)_3CSi$, 3 H–C(1) and 3 H–C(9)); 1.1–2.2 (*m*, 10 H, 2 H–C(2), 2 H–C(5), 2 H–C(6), 2 H–C(7) and 2 H–C(8)); 4.0–4.25 (*m*, 1 H, H–C(4)); 4.25–4.6 (*m*, 1 H, H–C(3)). – ^{13}C-NMR. ($CDCl_3$): 94.27 (C(3), *threo*); 93.28 (C(3), *erythro*); 73.65 (C(4), *erythro*); 73.25 (C(4), *threo*); 34.16, 33.51, 33.22, 32.12, 31.91, 25.79, 25.72, 24.41, 22.97, 22.82, 22.58, 21.58, 18.05, 13.99, 10.79, 10.40, –4.42, –4.82 and –5.38. *threo/erythro* = 2:1 (integration).

$C_{15}H_{33}NO_3Si$(303.50) Calc. C 59.36 H 10.96 N 4.62% Found C 59.47 H 10.95 N 4.55%

Data of 4-(t-butyl)dimethylsilyloxy-5-nitrododecane (**17**). GP III; yield 48%, b.p. 120°/0.01 Torr. – IR.: 1550 (NO_2), 1260, 840. – ^{1}H-NMR. ($CDCl_3$): –0.02 and 0.01 (2 *s*, 6 H, $(H_3C)_2Si$); 0.55–1.0 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(1) and 3 H–C(12)); 1.0–1.65 (*m*, 16 H, 2 H–C(2), 2 H–C(3), 2 H–C(6), 2 H–C(7), 2 H–C(8), 2 H–C(9), 2 H–C(10) and 2 H–C(11); 3.90–4.25 (*m*, 1 H, H–C(4)); 4.25–4.55 (*m*, 1 H, H–C(5)). – ^{13}C-NMR. ($CDCl_3$): 92.67 (C(5), *threo*); 91.72 (C(5), *erythro*); 73.49 (C(4), *erythro*); 73.28 (C(4), *threo*); 36.27, 35.43, 31.75, 29.41, 29.16, 29.02, 28.27, 27.48, 26.23, 26.04, 25.94, 25.78, 25.69, 22.66, 18.07, 16.50, 14.35, 14.07, –4.45, –5.30 and –5.38. *threo/erythro* = 2.2:1 (integration).

$C_{18}H_{39}NO_3Si$(345.60) Calc. C 62.56 H 11.37 N 4.05% Found C 62.72 H 11.37 N 4.04%

Data of 3-(t-butyl)dimethylsilyloxy-2-nitrotridecane (**18**). GP III; yield 45%, b.p. 130°/0.01 Torr. – IR.: 1550 (NO_2), 1260, 840, 780. – ^{1}H-NMR. ($CDCl_3$): –0.02, 0.04 and 0.1 (3 *s*, 6 H, $(H_3C)_2Si$); 0.75–1.05 (*m*, 12 H, $(H_3C)_3CSi$ and 3 H–C(13)); 1.1–1.75 (*m*, 21 H, 3 H–C(1) and 9 CH_2); 3.95–4.85 (*m*, 2 H, H–C(2) and H–C(3)). – ^{13}C-NMR. ($CDCl_3$): 87.05 (C(2), *threo*); 85.47 (C(2), *erythro*); 73.82 (C(3)); 34.80, 32.74, 32.00, 29.86, 29.66, 29.42, 25.73, 25.29, 23.22, 22.76, 17.99, 15.25, 14.16, 11.23, –4.45, –5.13 and –5.33. *threo/erythro* = 1:1 (integration).

$C_{19}H_{41}NO_3Si$(359.62) Calc. C 63.46 H 11.49 N 3.89% Found C 63.65 H 11.24 N 3.86%

Data of 6-(t-butyl)dimethylsilyloxy-7-nitrotetradecane (**19**). GP III; yield 65%, b.p. 130°/0.002 Torr. – IR.: 1550 (NO_2), 1255, 840, 780. – ^{1}H-NMR. ($CDCl_3$): 0.05 and 0.1 (2 *s*, 6 H, $(H_3C)_2Si$); 0.6–1.05 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(1) and 3 H–C(14)); 1.05–2.2 (*m*, 20 H, 10 CH_2); 3.95–4.25 (*m*, 1 H, H–C(6));

4.3–4.65 (*m*, 1 H, H–C(7)). – ^{13}C-NMR. ($CDCl_3$) (25.2 MHz): 92.63 (C(7), *threo*); 91.63 (C(7), *erythro*); 73.66 (C(6), *erythro*); 73.30 (C(6), *threo*); 34.01, 33.11, 31.99, 31.64, 29.37, 29.07, 28.89, 28.17, 26.14, 25.84, 25.69, 24.30, 22.68, 22.53, 17.97, 14.02, –4.48, –4.86 and –5.40. *threo/erythro* = 2:1 (integration).

$C_{20}H_{43}NO_3Si$(373.65) Calc. C 64.29 H 11.60 N 3.75% Found C 64.49 H 11.77 N 3.76%

Data of 3-(t-butyl)dimethylsilyloxy-2-methyl-4-nitrohexane (**20**). GP III; yield 54%, b.p. 110–115°/0.9 Torr. – IR.: 1550 (NO_2), 1255, 840, 780. – ^{1}H-NMR. ($CDCl_3$): 0.00 and 0.03 (2 *s*, 6 H, $(H_3C)_2Si$); 0.75–1.05 (*m*, 18 H, $(H_3C)_3CSi$, 3 H–C(1), H_3C–C(2) and 3 H–C(6)); 1.35–2.15 (*m*, 3 H, H–C(2) and 2 H–C(5)); 3.75–4.05 (*m*, 1 H, H–C(3)); 4.2–4.55 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. ($CDCl_3$): 94.56 (C(4), *threo*); 92.38 (C(4), *erythro*); 78.34 (C(3), *erythro*); 77.90 (C(3), *threo*); 32.80, 30.48, 26.07, 23.65, 22.60, 20.26, 18.95, 18.48, 18.38, 17.42, 15.23, 10.82, 10.40, –4.00, –4.18 and –4.95. *threo/erythro* = 1.3:1 (integration).

$C_{13}H_{29}NO_3Si$(275.46) Calc. C 56.68 H 10.61 N 5.08% Found C 56.80 H 10.74 N 5.05%

Data of 4-(t-butyl)dimethylsilyloxy-2-methyl-3-nitroheptane (**21**). GP III; yield 63%, b.p. 85°/0.01 Torr. – IR.: 1550 (NO_2), 1260, 840, 780. – ^{1}H-NMR. ($CDCl_3$): –0.01 and 0.15 (2 *s*, 6 H, $(H_3C)_2Si$); 0.65–1.15 (*m*, 18 H, $(H_3C)_3CSi$, 3 H–C(1), H_3C–C(2) and 3 H–C(7)); 1.15–1.75 (*m*, 4 H, 2 H–C(5) and 2 H–C(6)); 1.85–2.5 (*m*, 1 H, H–C(2)); 3.85–4.5 (*m*, 2 H, H–C(3) and H–C(4)). – ^{13}C-NMR. ($CDCl_3$): 97.66 (C(3), *threo*); 96.73 (C(3), *erythro*); 70.84 (C(4), *erythro*); 70.52 (C(4), *threo*); 35.26, 33.82, 28.54, 27.99, 25.58, 19.88, 18.88, 18.77, 18.46, 17.90, 16.59, 16.39, 14.21, 13.97, –4.43, –4.62 and –5.46. *threo/erythro* = 1:2 (integration).

Data of 1-(t-butyl)dimethylsilyloxy-2-nitro-1-phenylbutane (**22**). GP III; yield 86%, b.p. 85–90°/0.01 Torr. – IR.: 1550 (NO_2), 1260, 840, 780. – ^{1}H-NMR. ($CDCl_3$): –0.25, –0.2, 0.00 and 0.03, (4 *s*, 6 H, $(H_3C)_2Si$); 0.65–1.1 (*m*, 12 H, $(H_3C)_3CSi$ and 3 H–C(4)); 1.1–2.05 (*m*, 2 H, 2 H–C(3)); 4.35–4.75 (*m*, 1 H, H–C(2)); 5.0 (*d*, *J* = 9, 0.8 H, H–C(1), *threo*); 5.1 (*d*, *J* = 6, 0.2 H, H–C(1), *erythro*); 7.3 (*s*, 5 H, arom. H). *threo/erythro* = 4:1. – ^{13}C-NMR. ($CDCl_3$): 139.49, 128.82, 128.71, 128.44, 127.27, 126.57, 96.61 (C(2), *threo*); 95.92 (C(2), *erythro*); 77.07 (C(1), *threo*); 76.17 (C(1), *erythro*); 25.67, 25.48, 23.56, 21.38, 17.95, 10.48, 10.39, 10.18, –4.80, –5.43 and –5.72.

$C_{16}H_{27}NO_3Si$(309.48) Calc. C 62.10 H 8.79 N 4.53% Found C 62.06 H 8.74 N 4.54%

Data of 3-nitro-4-trimethylsilyloxyheptane (**36**). GP III; yield 95%, b.p. 60°/0.07 Torr. – IR.: 1550 (NO_2), 1380, 1255, 845, 755. – ^{1}H-NMR. (300 MHz, C_6D_6): 0.05 and 0.1 (2 *s*, 9 H, $(H_3C)_3Si$, two isomers); 0.6–0.8 (*m*, 6 H, 3 H–C(1) and 3 H–C(7)); 1.05–1.45 (*m*, 4 H, 2 H–C(5) and 2 H–C(6)); 1.45–1.6 (*m*) and 1.9–2.05 (*m*) (2 H, 2 H–C(2), two isomers); 3.9–4.05 (*m*, 1 H); 4.05–4.15 (*m*, 0.3 H); 4.15–4.27 (*m*, 0.7 H). *threo/erythro* = 2:1. – ^{13}C-NMR. ($CDCl_3$) (75.5 MHz): 95.22 (C(3), *threo*); 93.84 (C(3), *erythro*); 73.65 (C(4), *threo*); 73.50 (C(4), *erythro*); 36.25, 35.58, 23.12, 21.71, 18.39, 17.64, 14.05, 13.90, 10.54, 10.23, 0.08 and –0.06.

$C_{10}H_{23}NO_3Si$ (233.38) Calc. C 51.46 H 9.93 N 6.00% Found C 51.54 H 9.94 N 5.95%

Data of 2-nitro-3-trimethylsilyloxyoctane (**37**). GP III; yield 93%, b.p. 75°/0.1 Torr. – IR.: 1550 (NO_2), 1390, 1255, 840, 755. – ^{1}H-NMR. (300 MHz, C_6D_6): 0.06 and 0.09 (2 *s*, 9 H, $(H_3C)_3Si$, two isomers); 0.8–0.9 (2 overlapping *t*, *J* = 7 and 7, 3 H, 3 H–C(8)); 0.93 (*d*, *J* = 7, H–C(1), one isomer); 1.0–1.35 (*d* superimposed on br. *m*, *J* = 7, 4 CH_2 and H–C(1), the other isomer); 3.9–4.0 (*m*, 1 H); 4.2–4.35 (*m*, 1 H). *threo/erythro* = 1:1. – ^{13}C-NMR. (75.5 MHz, $CDCl_3$): 88.2 (C(2), *threo*); 86.08 (C(2), *erythro*); 74.44 (C(3), *erythro*); 74.06 (C(3), *threo*); 34.56, 32.84, 31.81, 31.63, 25.25, 24.03, 22.49, 15.52, 13.89, 11.50 and –0.20.

$C_{11}H_{25}NO_3Si$(247.41) Calc. C 53.40 H 10.19 N 5.66% Found C 53.43 H 10.22 N 5.64%

Data of 2-nitro-1-phenyl-1-trimethylsilyloxybutane (**38**). GP III; yield 97%, b.p. 90°/0.09 Torr, m.p. 44–49°. – IR.: 1550 (NO_2), 1375, 1255, 845, 755, 705. – ^{1}H-NMR. (300 MHz, C_6D_6): –0.05 and –0.04

(2 *s*, 9 H, $(H_3C)_3Si$); 0.5 (*t*, $J=7$) and 0.6 (*t*, $J=7$) (3 H, 3 H–C(4), two isomers); 0.8–1.0 (*m*), 1.4–1.7 (*m*) and 2.0–2.2 (*m*) (2 H, 2 H–C(3), two isomers); 4.3–4.4 (*m*) and 4.45–4.6 (*m*) (1 H, H–C(2), two isomers); 4.92 (*d*, $J=9$, 0.75 H, H–C(1), *threo*); 5.12 (*d*, $J=6$, 0.25 H, H–C(1), *erythro*). *threo*/*erythro* = 3:1. – ^{13}C-NMR. (75.5 MHz, $CDCl_3$): 139.94, 139.52, 128.94, 128.86, 128.59, 128.54, 127.30, 126.53, 96.66 (C(2), *threo*); 95.82 (C(2), *erythro*); 76.91 (C(1), *threo*); 76.01 (C(1), *erythro*); 23.64, 21.72, 10.52, 10.25, −0.16 and −0.25.

$C_{13}H_{21}NO_3Si$(267.40) Calc. C 58.39 H 7.92 N 5.24% Found C 58.42 H 8.03 N 5.25%

6. Independent synthesis of *erythro*-2-(*t*-butyl)dimethylsilyloxy-1-ethyl-butylamine (23a). – *Preparation of (E)-3,4-epoxyhexane* (**24**). *m*-Chloroperbenzoic acid (7.32 g, *ca.* 85%, 36 mmol) in CH_2Cl_2 (60 ml) was added dropwise to an ice-cooled solution of *trans*-3-hexene (3 g, 35.7 mmol) in CH_2Cl_2 (20 ml). The mixture was stirred at 0° for 4 h. The precipitated *m*-chlorobenzoic acid was removed by filtration and the filtrate washed twice with 5% aq. $NaHCO_3$-solution, water and sat. NaCl-solution. After drying ($MgSO_4$), fractional distillation at atmospheric pressure afforded **24** (2.12 g, 60%), b.p. 104–106° at ambient pressure ([10]: b.p. 104–106°/ambient pressure). – ^{1}H-NMR. ($CDCl_3$): 0.87–1.15 (*m*, 6 H, 3 H–C(4) and 3 H–C(2′)); 1.4–1.75 (*m*, 4 H, 2 H–C(3) and 2 H–C(1′)); 2.57–2.75 (*m*, 2 H, H–C(1) and H–C(2)).

Preparation of erythro-*4-amino-3-hexanol* (**26a**). A mixture of **24** (1 g, 10 mmol) and sat. aq. NH_4OH-solution (40 ml) was shaken for 5 h at 100° in an autoclave. After evaporation of the solvent, the residue was dissolved in CH_2Cl_2 and the solution dried ($MgSO_4$). Reevaporation followed by bulb-to-bulb distillation (100°/100 Torr) gave the product (0.7 g, 60%), as hydroscopic colorless crystals, m.p. 47–48°. – IR. ($CHCl_3$): 3400 (OH), 2960, 1460, 1090. – ^{1}H-NMR. ($CDCl_3$) (300 MHz): 0.96 (*t*, $J=7.3$, 3 H, 3 H–C(1 or 6)); 0.99 (*t*, $J=7.3$, 3 H, 3 H–C(6 or 1)); 1.19–1.56 (*m*, 4 H, 2 H–C(2) and 2 H–C(5)); 1.73 (br. *s*, 3 H, OH and NH_2); 2.66–2.71 (*d*×*t*, $J=4.0$ and 9.0, 1 H, H–C(4)); 3.37–3.43 (*d*×*t*, $J=4.0$ and 8.9, 1 H, H–C(3)). – ^{13}C-NMR. (D_2O, MeOH as internal standard): 77.06 (C(3)), 57.07 (C(4)), 25.22, 25.15, 10.99 and 10.70. The product was analyzed as its *p*-toluenesulfonyl amide derivative.

$C_{13}H_{21}NO_3S$	Calc.	C 57.54	H 7.80	N 5.16	S 11.81%
(271.35)	Found	„ 57.42	„ 7.85	„ 5.04	„ 11.67%

Preparation of erythro-*2-(t-butyl)dimethylsilyloxy-1-ethyl-butylamine* (**23a**). Dry triethylamine (0.61 g, 6.1 mmol) was added to a mixture of **26a** (0.5 g, 4.25 mmol), (*t*-butyl)dimethylsilylchloride (0.75 g, 5 mmol), 4-dimethylaminopyridine (*ca.* 2 mg) and dry CH_2Cl_2 (4 ml). The mixture was stirred at 20° for 12 h. The CH_2Cl_2 and triethylamine were evaporated and the residue was treated with hexane and filtered. The filtrate was evaporated to give an oil, which on distillation (bulb-to-bulb) at 100°/0.1 Torr gave the product as a colorless liquid (0.53 g, 55%). – IR.: 3300 (NH_2), 2960, 1460, 1250, 840, 760. – ^{1}H-NMR. ($CDCl_3$): 0.03 (*s*, 6 H, $(H_3C)_2Si$); 0.73–1.0 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(4) and 3 H–C(2′)); 1.22–1.63 (*m*, 6 H, 2 H–C(3), 2 H–C(1′) and NH_2); 2.5–2.75 (*m*, 1 H, H–C(1)); 3.33–3.6 (*m*, 1 H, H–C(2)). – ^{13}C-NMR. ($CDCl_3$): 76.33 (C(2)); 56.34 (C(1)); 25.26, 24.84, 22.67, 17.20, 10.35, 9.48 and −5.31.

$C_{12}H_{29}NOSi$(231.52) Calc. C 62.27 H 12.63 N 6.05% Found C 62.32 H 12.79 N 6.00%

7. Independent synthesis of *threo*-2-(*t*-butyl)dimethylsilyloxy-1-ethyl-butylamine (23b). – *Preparation of* threo-*4*-N-p-*toluenesulfonylamino-3-hexanol* (**25**). To a stirred suspension of chloramine T (12.6 g, 44.4 mmol) in *t*-butyl alcohol (60 ml) was added a solution of osmium tetroxide in *t*-butyl alcohol (0.04M, 8.94 ml, 0.36 mmol) followed by *trans*-3-hexene (3 g, 35.7 mmol). The mixture was stirred at 55–60° for 60 h and then cooled to 20°. $NaBH_4$ (0.4 g, 1.07 mmol) was added and stirring continued for a further 1.5 h. After evaporation of the solvent, the residue was treated with CH_2Cl_2. The resulting solution was washed twice with sat. NaCl-solution containing 1% aq. NaOH-solution, dried ($MgSO_4$) and evaporated. The crude product (8.9 g, 89%) was purified by column chromatography (*florisil*, CH_2Cl_2). Recrystallization from ethyl acetate furnished **25** (6.4 g, 64%) as colorless crystals, m.p. 103–104°. – IR. ($CHCl_3$): 3380, 2960, 1330, 1160, 1090. – ^{1}H-NMR. ($CDCl_3$): 0.65–0.95 (two overlapping *t*, $J=6$, 6 H, 3 H–C(1) and 3 H–C(6)); 1.25–1.75 (*m*, 5 H, 2 H–C(2), 2 H–C(5) and OH); 2.45 (*s*, 3 H,

H_3C-Ar); 2.95–3.3 (*m*, 1 H, H–C(4)); 3.4–3.65 (*m*, 1 H, H–C(3)); 4.6–4.8 (br. *d*, *J* = 9, 1 H, NH); 7.25 (*d*, *J* = 9, 2 H, arom. H); 7.77 (*d*, *J* = 9, 2 H, arom. H).

$C_{13}H_{21}NO_3S$	Calc.	C 57.55	H 7.80	N 5.15	S 11.80%
(271.35)	Found	„ 57.45	„ 7.80	„ 5.20	„ 11.80%

Preparation of threo-*4-amino-3-hexanol* (**26b**). Ammonia (20 ml) was condensed into a flask containing **25** (4.47 g, 15.8 mmol) at −78°. Sodium (*ca.* 1 g, 47 mmol) was added to the mechanically stirred mixture in small portions until the blue coloration persisted for 1 h. After a further 2 h sodium acetate trihydrate was added until the blue coloration disappeared. The mixture was warmed to 20° and left for 12 h. The residue obtained after evaporation of the ammonia was treated with CH_2Cl_2 and stirred for 10 min. Filtration, followed by drying ($MgSO_4$) and evaporation of the filtrate, gave on oil (1.23 g) which on bulb-to-bulb distillation at 80°/100 Torr gave the product as hygroscopic colorless crystals (0.7 g, 38%), m.p. 44.5–45.5°. – IR. ($CHCl_3$): 3400, 2960, 1460, 1090, 970. – ^{1}H-NMR. (300 MHz, $CDCl_3$): 0.94–1.00 (two overlapping *t*, *J* = 5.2 and 6, 6 H, 3 H–C(1) and 3 H–C(6)); 1.18–1.66 (*m*, 4 H, 2 H–C(2) and 2 H–C(5)); 2.22 (br. *s*, 3 H, OH and NH_2); 2.46–2.53 (*d* × *d* × *d*, *J* = 4.4, 5.7 and 10.2, 1 H, H–C(4)); 3.18–3.24 (*d* × *d* × *d*, *J* = 4.1, 5.7 and 8.2, 1 H, H–C(3)). – ^{13}C-NMR. (D_2O-internal standard MeOH): 76.53 (C(3)); 56.59 (C(4)); 26.55, 10.94 and 10.64.

Preparation of threo-*2-(t-butyl)dimethylsilyloxy-1-ethyl-butylamine* (**23b**). Compound **26b** was silylated following the procedure described for the preparation of the *erythro*-isomer (**23a**). Bulb-to-bulb distillation of the crude product gave **23b** as a colorless liquid (54%), b.p. 100°/0.1 Torr. – IR.: 3300, 2960, 1460, 1250, 840, 760. – ^{1}H-NMR. ($CDCl_3$): 0.02 (*s*, 6 H, $(H_3C)_2Si$); 0.6–1.1 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(4) and 3 H–C(2′)); 1.2–1.7 (*m*, 6 H, 2 H–C(3), 2 H–C(1′) and NH_2); 2.35–2.6 (*m*, 1 H, H–C(1)); 3.25–3.5 (*m*, 1 H, H–C(2)). – ^{13}C-NMR. ($CDCl_3$): 76.20 (C(2)); 54.95 (C(1)); 26.89, 26.08, 25.56, 17.81, 10.84, 9.33, −3.77 and −4.22.

$C_{12}H_{29}NOSi$(231.52) Calc. C 62.27 H 12.63 N 6.05% Found C 62.08 H 12.06 N 5.65%

8. General procedures for the preparation of nitroaldols *via* doubly deprotonated nitroaldols *28*. – *General Procedure V* (GP V) (from nitroaldols **1**). A stirred solution of diisopropylamine (21 mmol) in THF (45 ml) was treated at −78° with a hexane solution of BuLi (21.7 mmol). The cooling bath was removed and stirring was continued for 40 min after which time the cooling bath was replaced. HMPT (10 ml) was added, and the nitroaldol (10 mmol) was introduced to the cold (−78°) solution. The mixture was stirred for 1 h, cooled to −100° (methanol/liquid N_2 bath), and glacial acetic acid/THF 2:1 (9 ml) was added when the internal temp. rose to −65°. It was then stirred for 1.5 h during which period the internal temp. rose to about −50°. The mixture was poured into a mixture of ether (300 ml) and water (80 ml). The organic phase was separated and washed with water (8 × 80 ml). After drying ($MgSO_4$) the solvent was distilled off in a rotatory evaporator to obtain the crude product. This was purified by bulb-to-bulb distillation.

General Procedure VI (GP VI) (from nitroalkanes [1] [5] [49]). To a stirred, cold (< −90°)[26]) solution of the nitroalkane (10 mmol) in THF/cosolvent (60 ml, cosolvent and THF/cosolvent ratio as mentioned in *Table 2*) was added dropwise a solution of BuLi (20.5 mmol) in hexane (in case of DMPU cosolvent the internal temp. was maintained below −88°). The solution was warmed up to −60° over 1 h 15 min, cooled to −76° and the aldehyde was added. After stirring between −70° and −60° for 1.5 h the mixture was cooled rapidly below −90°[26]) and acidified with 6.5 ml acetic acid/THF 3.5:3 without allowing the internal temp. to rise above −85°. The cooling bath was removed and the acidified mixture was allowed to warm up to r.t. It was then poured into a mixture of ether (300 ml) and water (100 ml) and worked up as described in GPV. Unless otherwise stated, the crude product was purified by bulb-to-bulb distillation.

Data of 3-nitro-4-heptanol (**4b**/**4a**). GP V; yield 51%, b.p. 130–140°/12 Torr. *threo*/*erythro* = 2.6:1 (p.h., ^{13}C-NMR.).

---

[26]) At this low temp. the cosolvent often precipitated; with HMPT the reaction could still be stirred but with DMPU the precipitate was too thick to stir. To avoid this problem, the mixture was cooled rapidly and the addition was completed before any precipitation ensued. The precipitation was particularly troublesome when 33% DMPU in THF was used as the solvent.

Data of 2-nitro-3-octanol (**5b/5a**). GP VI (HMPT), yield 71%. – ^{1}H-NMR. ($CDCl_3$): 0.7–1.1 (br. *t*, 3 H, 3 H–C(8)); 1.1–1.85 (overlapping *m* and *d* (J=6), 11 H, 3 H–C(1) and 4 CH_2); 2.55 (br. *s*, 1 H, OH); 3.7–4.35 (br. *m*, 1 H, H–C(3)); 4.55 (*qi*, J=6, 1 H, H–C(2)). – ^{13}C-NMR. ($CDCl_3$) (75.5 MHz): 87.69 (C(2), *threo*); 86.26 (C(2), *erythro*); 72.67 (C(3), *threo*); 72.10 (C(3), *erythro*); 32.92, 32.42, 31.28, 25.08, 24.49, 22.19, 15.50, 13.57 and 11.98. *threo/erythro* = 4.4:1 (integration).

Silylation (GP IV) *of* **5b/5a** furnished *3-(t-butyl)dimethylsilyloxy-2-nitrooctane* (**15b/15a**), yield 60%, b.p. 115°/0.07 Torr. – IR.: 1550 (NO_2), 1260, 840, 780. – ^{1}H-NMR. (300 MHz, C_6D_6): 0.15, 0.17, 0.19 and 0.22 (4 *s*, 6 H, $(H_3C)_2Si$); 0.98–1.12 (overlapping *t* (J=7.3), 2 *s* and *d* (J=6.2), 3 H–C(8), $(H_3C)_3CSi$ and 3 H–C(1) (*threo*)); 1.17–1.5 (overlapping *d* (J=6.6) and *m*, 3 H–C(1) (*erythro*) and 4 CH_2); 4.11 (*d*×*qa*, J=3 and 6.5, H–C(2), *erythro*); 4.15 (*t*×*d*, J=4 and 8, H–C(3), *threo*); 4.42 (*d*×*t*, J=3 and 6.5, H–C(3), *erythro*); 4.49 (*qa*×*d*, J=7 and 8, H–C(2), *threo*). – ^{1}H-NMR. (300 MHz, C_6D_6): 4.12 (*t*×*d*, J=4 and 8, H–C(3), *threo*); 4.31 (*d*×*t*, J=3.5 and 7.5, H–C(3), *erythro*); 4.45 (*d*×*qa*, J=3.5 and 6.5, H–C(2), *erythro*); 4.56 (*qa*×*d*, J=7 and 8, H–C(2), *threo*) (other signals are not included here). – ^{13}C-NMR. (75.5 MHz, $CDCl_3$): 86.86 (C(2), *threo*); 85.32 (C(2), *erythro*); 73.67 (C(3)); 34.53, 32.53, 31.86, 31.62, 25.63, 25.51, 22.76, 22.34, 17.78, 15.00, 13.76, 11.02, –4.73, –5.38 and –5.59. *threo/erythro* = 4:1 (integration).

Data of 2-methyl-4-nitro-3-hexanol (**10b/10a**). GP V, yield 31%, b.p. 75–95°/2 Torr, *threo/erythro* = 3.5:1 (p.h., ^{13}C-NMR.). – GP VI (HMPT), yield 61%. – ^{1}H-NMR. (CCl_4 and HCl-gas): 0.8–1.1 (*m*, 9 H, 3 H–C(1), H_3C–C(2) and 3 H–C(6)); 1.35–2.2 (*m*, 3 H, H–C(2) and 2 H–C(5)); 2.35 (br. *s*, 1 H, OH); 3.45 (*t*, J=6, 0.78 H, H–C(3), *threo*); 3.65 (*t*, J=6, 0.22 H, H–C(3), *erythro*); 4.25–4.6 (*m*, 1 H, H–C(4)). *threo/erythro* = 3.5:1.

Data of 2-nitro-1-phenyl-1-butanol (**12b/12a**). GP V, yield 48%, b.p. 110–120°/0.01 Torr, *threo/erythro* = 5.7:1 (from ^{1}H-NMR.). – GP VI (17% HMPT), yield 78%. – IR.: 3400, 1555 (NO_2), 1380 (NO_2). *threo/erythro* = 9:1 (from ^{1}H-NMR.). – GP VI (DMPU), yield 65%, *threo/erythro* = 9:1 (from ^{1}H-NMR.).

Silylation of **12b** (obtained from GP VI (HMPT)) following GP III gave *1-(t-butyl)dimethylsilyloxy-2-nitro-1-phenylbutan* (**22b/22a**). Yield 80%, *threo/erythro* = 7:1 (from ^{1}H-NMR.).

Reduction of **22b/22a** following GP I gave *1-[1'-(t-butyl)dimethylsilyloxy-1'-phenyl]methyl-propylamine*, yield 91%, b.p. 100°/0.005 Torr. – IR.: 3380, 1260, 1060, 840, 780, 700. – ^{1}H-NMR. ($CDCl_3$): –0.2 (*s*, 3 H, H_3CSi); 0.0 (*s*, 3 H, H_3CSi); 0.9 (br. *s*, 12 H, $(H_3C)_3CSi$ and 3 H–C(3)); 1.1–1.5 (*m*, 4 H, NH_2 and 2 H–C(2)); 2.5–2.85 (*m*, 1 H, H–C(1)); 4.35–4.5 (*d*, J=5.5, 1 H, H–C(1')); 7.3 (*s*, 5 H, arom. H). – ^{13}C-NMR. ($CDCl_3$): 143.17, 127.98, 127.25, 126.85, 79.20 (C(1'), *threo*); 90.02 (C(1'), *erythro*); 60.11 (C(1), *threo*); 59.54 (C(1), *erythro*), 26.45, 25.90, 25.58, 18.22, 11.04, 10.84, –4.43, –4.57 and –5.01, *threo/erythro* = 7.8:1.

$C_{16}H_{29}NOSi$(279.49) Calc. C 68.76 H 10.46 N 5.01% Found C 68.59 H 10.53 N 4.84%

This silyloxyamino compound was desilylated (GP VIII) to *2-amino-1-phenyl-1-butanol:* yield 44%. – ^{1}H-NMR. ($CDCl_3$): 0.7–1.1 (2 overlapping *t*, 3 H, 3 H–C(4)); 1.1–1.5 (*m*, 2 H, 2 H–C(3)); 1.9 (br. *s*, 3 H, NH_2 and OH); 2.6–3.0 (*m*, 1 H, H–C(2)); 4.35 (*d*, J=6, 0.8 H) and 4.6 (*d*, J=4.5, 0.2 H) (H–C(1)). *threo/erythro* = 4:1.

Data of 2,2-dimethyl-4-nitro-3-hexanol (**29**). GP VI (HMPT); yield 53%, b.p. 60–70°/0.01 Torr. – IR.: 3500, 1550, 1370, 1130. – ^{1}H-NMR. (CCl_4 and HCl-gas): 0.9–1.1 (overlapping *s* and *t*, 12 H, 3 H–C(1), 3 H–C(6) and 2 H_3C–C(2)); 1.5–2.5 (*m*, 3 H, 2 H–C(5) and OH); 3.25 (*d*, J=2.5, 0.85 H, H–C(3), *threo*); 3.65 (*d*, J=3, 0.15 H, H–C(3), *erythro*); 4.55 (*d*×*d*×*d*, J=3, 5.5 and 10.5, 1 H, H–C(4)). *threo/erythro* = 5.6:1.

$C_8H_{17}NO_3$(175.23) Calc. C 54.83 H 9.78 N 7.99% Found C 55.03 H 9.93 N 7.82%

This compound was reduced (GP I) to obtain *4-amino-2,2-dimethyl-3-hexanol:* yield 63%. – ^{1}H-NMR. ($CDCl_3$): 0.7–1.1 (overlapping *t* and *s*, 12 H, 3 H–C(1), 2 H_3C–C(2) and 3 H–C(6)); 1.1–1.7 (*m*, 2 H, 2 H–C(5)); 2.35 (br. *s*, 3 H, OH and NH_2); 2.8–3.1 (*m*, H–C(4) and major isomer H–C(3)); 3.25 (*d*, J=3, minor isomer H–C(3)).

Data of 2-nitro-1-(p-tolyl)-1-butanol (**30**). GP VI (DMPU); yield 59%, purified by removing lower boiling impurities at 65°/0.003 Torr, no distillation at 130°/0.003 Torr and retrocondensation at 140° 0.003 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.83 (*t*, J=7, 3 H, 3 H–C(4)); 1.1–2.15 (*m*, 2 H, 2 H–C(3)); 2.35

(*s*, 3 H, H_3C-Ar); 3.4 (br. *s*, 1 H, OH); 4.55 (overlapping $d \times d \times d$, $J = 4$, 9 and 9, 1 H, H–C(2)); 4.96 (*d*, $J = 9$, H–C(1), *threo*); 5.07 (*d*, $J = 5$, H–C(1), *erythro*); 7.23 (*s*, 4 H, arom. H). *threo/erythro* = 9:1 (from 300-MHz-^{1}H-NMR.).

Data of 1-(2'-methoxyphenyl)-2-nitro-1-butanol (**31**). GP VI (HMPT); yield 72%, b.p. 100°/$8 \cdot 10^{-6}$ Torr. – ^{1}H-NMR. ($CDCl_3$): 0.7–1.15 (2 overlapping *t*, $J = 7.5$ and 7.5, 3 H, 3 H–C(4)); 1.15–2.3 (*m*, 2 H, 2 H–C(3)); 3.4 (br. *s*, 1 H, OH); 3.84 (*s*, 3 H, OCH_3); 4.65–5.0 (*m*, 1 H, H–C(2)); 5.15 (br. *d*, 1 H, H–C(1)); 6.8–7.45 (*m*, 4 H, arom. H). *threo/erythro* = 2.2:1 (from 300-MHz-^{1}H-NMR.). – GP IV (DMPU); yield 39%, *threo/erythro* = 3:1 (from 300-MHz-^{1}H-NMR.).

$C_{11}H_{15}NO_4$(225.24) Calc. C 58.66 H 6.71 N 6.22% Found C 58.66 H 6.83 N 6.10%

Data of 1-(4'-methoxyphenyl)-2-nitro-1-butanol (**32**). GP VI (DMPU); yield 20%, purified by removing lower boiling impurities at $50°/2 \cdot 10^{-4}$ Torr; the compound decomposed at $85°/7 \cdot 10^{-5}$ Torr (no distillation at lower temperatures). – ^{1}H-NMR. ($CDCl_3$): 0.85 (*t*, $J = 7$, 3 H, 3 H–C(4)); 1.1–2.2 (*m*, 2 H, 2 H–C(3)); 2.75 (br. *s*, 1 H, OH); 3.78 (*s*, 3 H, OCH_3); 4.58 (overlapping $d \times d \times d$, $J = 3.5$, 9.0 and 9.0, 1 H, H–C(2)); 4.85–5.05 (2 overlapping *d*, $J = 4$ and 9.5, 1 H, H–C(1)); 6.9 (*d*, $J = 9$, 2 H, H–C(3') and H–C(5')); 7.25 (*d*, $J = 9$, 2 H, H–C(2') and H–C(6')). *threo/erythro* = 15.7:1 (from 300-MHz-^{1}H-NMR.).

Data of 1-(2'-fluorophenyl)-2-nitro-1-butanol (**33**). GP VI (HMPT); yield 75%, b.p. 140°/0.005 Torr. – IR.: 3500 (OH), 1550 (NO_2), 815, 760. – ^{1}H-NMR. ($CDCl_3$): 0.9 (*t*, $J = 7$, 3 H, 3 H–C(4)); 1.2–2.4 (*m*, 2 H, 2 H–C(3)); 3.4 (br. *s*, 1 H, OH); 4.55–4.85 (*m*, 1 H, H–C(2)); 5.25–5.6 (2 overlapping *d*, $J = 4$ and 8.5, 1 H, H–C(1)); 6.9–7.7 (*m*, 4 H, arom. H). *threo/erythro* = 3.5:1 (from 300-MHz-^{1}H-NMR.). – GP VI (25% DMPU); yield 58%, *threo/erythro* = 2.1:1 (from 300-MHz-^{1}H-NMR.). – GP VI (33% DMPU); yield 50%, *threo/erythro* = 1:2.4 (from 300-MHz-^{1}H-NMR.).

$C_{10}H_{12}FNO_3$(213.21) Calc. C 56.33 H 5.67 N 6.57% Found C 56.34 H 5.80 N 6.53%

Data of 1-(4'-fluorophenyl)-2-nitro-1-butanol (**34**). GP VI (DMPU); yield 45%, purified by removing lower boiling impurities at $60°/8 \cdot 10^{-5}$ Torr; the compound decomposed at $90°/4 \cdot 10^{-6}$ Torr (no distillation at lower temperatures). – ^{1}H-NMR. ($CDCl_3$): 0.85 (*t*, $J = 7.5$, 3 H, 3 H–C(4)); 1.1–2.25 (*m*, 2 H, 2 H–C(3)); 3.2 (br. *s*, 1 H, OH); 4.55 ($d \times d \times d$, $J = 3.5$, 9.0 and 9.0, 1 H, H–C(2)); 4.95–5.2 (2 overlapping *d*, $J = 6$ and 9, 1 H, H–C(1)); 6.95–7.5 (*m*, 4 H, arom. H). *threo/erythro* = 11.5:1 (from 300-MHz-^{1}H-NMR.).

9. Deprotonation/protonation of (*t*-butyl)dimethylsilyl- and trimethylsilylether of nitroaldols. – *General procedure VII* (GP VII). A stirred solution of diisopropylamine (5.4 mmol) in THF (22 ml) was treated at –78° with BuLi (5.6 mmol) in hexane. The cooling bath was removed and stirring continued for 40 min after which time the cooling bath was replaced. The silylated nitroaldol (5 mmol) was added and the solution stirred at –78° for 1 h and subsequently cooled to –100° (methanol/liquid N_2 bath). Glacial acetic acid/THF 1:1 (3 ml) was added and the mixture warmed to –84° over 30 min. In the case of trimethylsilylethers the mixture was allowed to warm up to about 10° over 15 h. It was poured into ether/water. Extraction with ether was followed by washing of the ether extracts with water (3 times), sat. aq. NaCl-solution, drying ($MgSO_4$) and evaporation at 10 Torr and finally at 0.1 Torr to remove residual acetic acid. The crude product thus obtained was purified by bulb-to-bulb distillation. If there was any trace of desilylated product in the distillate it was removed by chromatography (see GP II).

Desilylation of silyloxyamino compounds to aminoalcohols. – *General procedure VIII* (GP VIII), *using tetrabutylammonium fluoride.* To the silyloxyamino compound (2.3 mmol) was added a Bu_4NF-solution in THF (6.5 ml, 2.6 mmol) [15] and the solution was stirred overnight (13 h) at r.t. The mixture was poured into 0.7N HCl (30 ml) and the aqueous layer was washed with CH_2Cl_2 (3 × 20 ml). The aqueous phase was then basified with 7% NaOH-solution (10 ml) and extracted with CH_2Cl_2 (3 × 20 ml). After drying ($MgSO_4$) the organic phase was stripped of solvent (rotary evaporator) and the residual yellow liquid was bulb-to-bulb distilled to obtain the aminoalcohol as a colorless oil.

General procedure IX (GP IX) *(lithium aluminium hydride reduction).* To a solution of the silyloxyamino compound (2.2 mmol) in anh. ether (40 ml) was added LAH (5.2 mmol) and the suspension was refluxed for 5 h. The mixture was cooled in an ice bath and hydrolyzed by sequential addition of cold

water (0.3 ml), saturated NaOH-solution (0.5 ml) and water (0.3 ml). The supernatant liquid was decanted and the residue was washed with ether (2 × 25 ml). The combined etheral layers were stripped of solvent (rotary evaporator) and the residue was bulb-to-bulb distilled to obtain the pure product.

Data of 3-(t-butyl)dimethylsilyloxy-4-nitrohexane (**13a**). GP VII; yield 81%, b.p. 120°/0.2 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.06 (*s*, 6 H, $(H_3C)_2Si$); 0.73–1.1 (overlapping *s* and *t*, 15 H, $(H_3C)_3CSi$, 3 H–C(1) and 3 H–C(6)); 1.4–2.25 (*m*, 4 H, 2 H–C(2) and 2 H–C(5)); 4.0 (*qa*, *J* = 5.5, 1 H, H–C(3)); 4.35 (*d* × *d* × *d*, *J* = 4, 5.5 and 10, 1 H, H–C(4)). – ^{13}C-NMR. ($CDCl_3$): 92.53 (C(4)); 74.14 (C(3)); 26.61, 25.49, 21.54, 17.78, 10.49, 8.61, −4.60 and −5.11.

Reduction (GP I) *of* **13a** gave erythro-*4-amino-3-(t-butyl)dimethylsilyloxyhexane* (**23a**); yield 68%. – ^{1}H-NMR. ($CDCl_3$): 0.03 (*s*, 6 H, $(H_3C)_2Si$); 0.73–1.0 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(1) and 3 H–C(6)); 1.22–1.63 (*m*, 6 H, 2 H–C(2), 2 H–C(5) and NH_2); 2.5–2.75 (*m*, 1 H, H–C(4)); 3.33–3.6 (*m*, 1 H, H–C(3)). – ^{13}C-NMR. ($CDCl_3$): 76.31 (C(3)); 56.40 (C(4)); 25.12, 24.77, 22.78, 17.28, 10.41, 9.54 and −5.23.

Data of 3-nitro-4-heptanol (**14a**). GP VII; yield 50%, b.p. 85–90°/0.005 Torr. – ^{1}H-NMR. (CCl_4): 0.06 (*s*, 6 H, $(H_3C)_2Si$); 0.9–1.2 (overlapping *s* and *t*, 15 H, $(H_3C)_3CSi$, 3 H–C(1) and 3 H–C(7)); 1.2–2.3 (*m*, 6 H, 2 H–C(2), 2 H–C(5) and 2 H–C(6)); 3.85–4.4 (*m*, 2 H, H–C(3) and H–C(4)). – ^{13}C-NMR. ($CDCl_3$): 93.35 (C(3)); 73.38 (C(4)); 36.37, 25.75, 21.58, 18.01, 14.06, 10.73, −4.46 and −4.88.

Data of 2-nitro-3-octanol (**15a**). GP VII; yield 72%, b.p. 90–95°/0.01 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.0 and 0.06 (2 *s*, 6 H, $(H_3C)_2Si$); all other signals are as described for **15**. – ^{13}C-NMR. ($CDCl_3$): 85.34 (C(2)); 73.93 (C(3)); 34.54, 31.63, 25.55, 24.76, 22.37, 17.83, 13.79, 11.04, −4.62 and −5.32.

Reduction of **15a** (GP I) gave *1-methyl-2-(t-butyl)dimethylsilyloxyheptylamine;* yield 73%, b.p. 80–90°/0.003 Torr. – IR.: 1460, 1250, 840, 775. – ^{1}H-NMR. ($CDCl_3$): 0.0 (*s*, 6 H, $(H_3C)_2Si$); 0.7–1.1 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(1′) and 3 H–C(7)); 1.1–1.6 (*m*, 10 H, 4 CH_2 and NH_2); 2.9 (*d* × *qa*, *J* = 4 and 6.5, 1 H, H–C(1)); 3.3–3.65 (*m*, 1 H, H–C(2)).

This compound was then desilylated (GP VIII) to *2-amino-3-octanol*, yield 43%, b.p. 70–80°/0.01 Torr. – IR.: 3350, 1585, 1460. – ^{1}H-NMR. ($CDCl_3$): 0.8–1.1 (overlapping *d* × *t*, 6 H, 3 H–C(1) and 3 H–C(8)); 1.15–1.65 (br. *s*, 8 H, 4 CH_2); 2.0 (*s*, 3 H, OH and NH_2); 2.95 (*d* × *qa*, *J* = 4 and 6.7, 1 H, H–C(2)); 3.3–3.6 (*m*, 1 H, H–C(3)). – ^{13}C-NMR. (C_6D_6): 75.59 (C(3), *threo*); 74.14 (C(3), *erythro*); 51.91 (C(2), *threo*); 51.25 (C(2), *erythro*); 34.50, 33.38, 32.51, 26.56, 26.00, 23.14, 19.86, 16.49, 15.61 and 14.34. *threo*/*erythro* = 1:4.4 (p.h.).

Data of 3-nitro-4-nonanol (**16a**). GP VII; yield 86%, b.p. 130–150°/0.001 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.0 (*s*, 6 H, $(H_3C)_2Si$); all other signals are as described for **16**. – ^{13}C-NMR. ($CDCl_3$): 92.99 (C(3)); 73.34 (C(4)); 33.83, 31.64, 25.52, 24.15, 22.34, 21.26, 17.79, 13.74, 10.52, −4.69 and −5.14.

Reduction (GP I) *of* **16a** gave *2-(t-butyl)dimethylsilyloxy-1-ethyl-heptylamine*, yield 83%, b.p. 75–80°/0.01 Torr. – IR.: 3400–3100, 1460, 1260, 835, 775. – ^{1}H-NMR. ($CDCl_3$): 0.0 (*s*, 6 H, $(H_3C)_2Si$); 0.75–1.05 (overlapping *s* and *t*, 15 H, $(H_3C)_3CSi$, 3 H–C(2′) and 3 H–C(7)); 1.05–1.65 (*m*, 12 H, 2 H–C(1′), 4 CH_2 and NH_2); 2.65 (*d* × *t*, *J* = 3.5 and 8, 1 H, H–C(1)); 3.4–3.65 (*m*, 1 H, H–C(2)). – ^{13}C-NMR. ($CDCl_3$): 76.80 (C(2)); 58.63 (C(1)); 33.03, 31.64, 26.85, 26.69, 26.51, 23.57, 19.04, 14.93, 12.15 and −3.46.

Samples of **16** were desilylated (**16a** with GP VIII, and a mixture of **16a**/**16b** with GP IX) to give *3-amino-4-nonanol* (**65**); GP VIII, yield 44%, b.p. 70–80°/0.01 Torr. – IR.: 3350, 1580, 1460. – ^{1}H-NMR. ($CDCl_3$): 0.95 (*t*, *J* = 6, 6 H, 3 H–C(1) and 3 H–C(9)); 1.1–1.6 (*m*, 10 H, 2 H–C(2) and 4 CH_2); 1.75 (*s*, 3 H, OH and NH_2); 2.65 (*d* × *t*, *J* = 3.5 and 8, 1 H, H–C(3)); 3.2–3.6 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. (C_6D_6): 73.82 (C(4)); 73.33 (C(4)); 57.62 (C(3)); 34.87, 32.42, 32.12, 27.17, 26.43, 26.04, 24.88, 23.09, 14.30, 11.18 and 10.65. – GP IX, yield 87%, b.p. 100°/0.8 Torr. – ^{1}H-NMR. (CCl_4): 0.7–1.0 (2 overlapping *t*, 6 H, 3 H–C(1) and 3 H–C(9)); 1.0–1.6 (br. *s*, 10 H, 2 H–C(2) and 4 CH_2); 1.95 (br. *s*, 3 H, NH_2 and OH); 2.1–2.7 (*m*, 1 H); 2.95–3.5 (*m*, 1 H). – ^{13}C-NMR. ($CDCl_3$): 73.22 (C(4)); 72.77 (C(4)); 57.44 (C(3)); 34.17, 31.82, 31.73, 26.01, 25.81, 25.36, 23.70, 22.52, 13.88, 10.77 and 10.20.

$C_9H_{21}NO$ (159.27) Calc. C 67.87 H 13.29 N 8.79% Found C 67.10 H 13.16 N 8.36%

Large-scale deprotonation/protonation of **16**. A stirred solution of lithium diisopropylamide prepared from diisopropylamine (15.2 ml, 108 mmol) in THF (180 ml) and BuLi in hexane (72 ml, 112 mmol), was cooled to −78° and **16** (27.8 g, 95 mmol, diastereomeric mixture) was added. The deep yellow solution was stirred for 1 h 45 min at −78° and subsequently cooled to −100°. Glacial

acetic acid/THF 3:2 (50 ml) was added when the solution became pale yellow. It was warmed to −84° over 30 min and then poured into ether/water. Extraction with ether, followed by washing of the ether extracts with water (3 times), sat. aq. NaCl-solution, drying ($MgSO_4$) and evaporation first at 10 Torr and then at 0.1 Torr gave the crude product (26.3 g), which was purified by bulb-to-bulb distillation. B.p. 130°/0.1 Torr, yield 22.6 g (79%). All the spectra were identical to those of the pure diastereomer **16a** as described above for the small-scale reaction.

Data of 4-(t-butyl)dimethylsilyloxy-5-nitrododecanol (**17a/17b**) GP VII; yield 80%, b.p. 130°/0.005 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.00 (*s*, 6 H, $(H_3C)_2Si$); all other signals are as described for **17**. – ^{13}C-NMR. ($CDCl_3$): 92.46 (C(5), *threo*); 91.52 (C(5), *erythro*); 73.28 (C(4), *erythro*); 73.05 (C(4), *threo*); 36.03, 35.21, 31.54, 29.21, 28.95, 28.80, 28.69, 28.04, 26.01, 25.85, 25.57, 22.44, 17.84, 16.27, 14.14, 13.89, −4.64, −5.03 and −5.56. *threo/erythro* = 1:4.5 (integration).

Data of 3-(t-butyl)dimethylsilyloxy-2-nitrotridecanol (**18a**). GP VII; yield 80%, b.p. 145–150°/0.005 Torr. – ^{1}H-NMR. ($CDCl_3$): −0.02 and 0.04 (2 *s*, 6 H, $(H_3C)_2Si$); 4.15–4.65 (*m*, 2 H, H−C(2) and H−C(3)); all other signals are as described for **18**. – ^{13}C-NMR. ($CDCl_3$): 85.41 (C(2)); 73.66 (C(3)); 34.63, 31.85, 29.49, 29.40, 29.26, 25.61, 25.13, 22.62, 17.89, 14.02, 11.13, −4.52 and −5.24.

H_2/Raney-nickel reduction (GP I) *of* **18a** gave *1-methyl-2-(t-butyl)dimethylsilyloxydodecylamine*, yield 70%, b.p. 130–140°/0.01 Torr. – IR.: 1460, 1255, 835, 775. – ^{1}H-NMR. ($CDCl_3$): 0.0 (*s*, 6 H, $(H_3C)_2Si$); 0.6–0.95 (*m*, 15 H, $(H_3C)_3CSi$, 3 H−C(1′) and 3 H−C(12)); 0.95–1.45 (*m*, 20 H, NH_2 and 9 CH_2); 2.7 (*d*×*qa*, *J* = 3.5 and 6.5, 1 H, H−C(1)); 3.15–3.5 (*m*, 1 H, H−C(2)).

The foregoing compound was then desilylated (GP VIII) to *2-amino-3-tridecanol*, yield 37%, b.p. 140°/0.005 Torr, m.p. 49–52°. – ^{1}H-NMR. ($CDCl_3$): 0.85–1.15 (overlapping *d* and *t*, 6 H, 3 H−C(1) and 3 H−C(13)); 1.15–2.1 (*m*, 21 H, OH, NH_2 and 9 CH_2); 2.95 (*d*×*qa*, *J* = 3.5 and 6.5, 1 H, H−C(2)); 3.25–3.65 (*m*, 1 H, H−C(3)). – ^{13}C-NMR. (C_6D_6): 74.57 (C(3)); 51.14 (C(2)); 33.27, 32.29, 30.16, 29.77, 26.91, 23.04, 17.15 and 14.32.

$C_{13}H_{29}NO$ (215.37) Calc. C 72.49 H 13.57 N 6.50% Found C 72.83 H 13.67 N 6.24%

Data of 6-(t-butyl)dimethylsilyloxy-7-nitrotetradecane (**19a**). GP VII; yield 77%, b.p. 145°/0.005 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.05 (*s*, 6 H, $(H_3C)_2Si$); all other signals are as described for **19**. – ^{13}C-NMR. ($CDCl_3$): 91.62 (C(7)); 73.66 (C(6)); 34.02, 31.71, 29.07, 28.95, 28.17, 26.14, 25.73, 24.29, 22.55, 17.97, 13.92, −4.44 and −4.86.

Data of 2-methyl-3-(t-butyl)dimethylsilyloxy-4-nitrohexane (**20a**). GP VII (in this case 17% HMPT (*v/v*) was added to the LDA-solution); yield 69%, b.p. 120–150°/0.9 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.08 and 0.1 (2 *s*, 6 H, $(H_3C)_2Si$); 3.85–4.0 (*m*, 1 H, H−C(3)); 4.3–4.5 (*m*, 1 H, H−C(4)); all other signals are as described for **20**. – ^{13}C-NMR. ($CDCl_3$): 92.37 (C(4)); 78.33 (C(3)); 32.81, 26.05, 22.60, 18.95, 18.37, 17.43, 10.83, −4.07 and −4.30.

This compound was reduced (GP I) to give *2-(t-butyl)dimethylsilyloxy-1-ethyl-3-methyl-butylamine*, yield 71%, b.p. 50°/0.001 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.00 (*s*, 6 H, $(H_3C)_2Si$); 0.7–1.1 (*m*, 18 H, $(H_3C)_3CSi$, 3 H−C(4), H_3C−C(3) and 3 H−C(2′)); 1.1–2.0 (*m*, 5 H, H−C(3), 2 H−C(1′) and NH_2); 2.5–2.8 (*m*, 1 H, H−C(1)); 3.35 (*d*×*d*, *J* = 6 and 7, 0.8 H, *erythro*, H−C(2)); 3.65–3.8 (*m*, 0.2 H, *threo*, H−C(2)). *threo/erythro* = 1:4. – ^{13}C-NMR. ($CDCl_3$): 80.88 (C(3)); 56.94 (C(4)); 30.01, 26.06, 25.70, 21.02, 18.28, 11.19, −3.86 and −4.15.

Data of 4-(t-butyl)dimethylsilyloxy-2-methyl-3-nitroheptane (**21a**). GP VII; yield 72%, b.p. 95–100°/0.02 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.06 and 0.1 (2 *s*, 6 H, $Si(CH_3)_2$); 4.1–4.5 (*m*, 2 H, H−C(3) and H−C(4)); all other signals are as described for **21**. – ^{13}C-NMR. ($CDCl_3$): 96.79 (C(3)); 70.88 (C(4)); 35.26, 27.99, 25.56, 19.86, 17.90, 16.59, 16.38, 14.20, −4.45 and −5.48.

Data of 1-(t-butyl)dimethylsilyloxy-2-nitro-1-phenylbutane (**22a**). GP VII (in this case 17% HMPT (*v/v*) was added to the LDA-solution): yield 76%, b.p. 120–125°/0.01 Torr. – ^{1}H-NMR. ($CDCl_3$): =0.25, −0.2, 0.00 and 0.05 (4 *s*, 6 H, $(H_3C)_2Si$), 4.95 (*d*, *J* = 9, 0.16 H, H−C(1), *threo*); 5.05 (*d*, *J* = 6, 0.84 H, H−C(1), *erythro*); all other signals are as described for **22**.

Data of 3-nitro-4-trimethylsilyloxy-heptane (**36a**). GP VII; yield 78%, b.p. 65–70°/0.6 Torr. – IR.: 1550 (NO_2), 1255, 845. – ^{1}H-NMR. (300 MHz, C_6D_6): 0.05 (*s*, 9 H, $(H_3C)_3Si$); 0.6–0.8 (*m*, 6 H, 3 H−C(1) and 3 H−C(7)); 0.9–1.6 (*m*, 4 H, 2 H−C(5) and 2 H−C(6)); 1.9–2.05 (*m*, 2 H, 2 H−C(2)); 3.9–4.05 (*m*, 1 H, H−C(3)); 4.08–4.15 (*d*×*d*×*d*, *J* = 3, 5 and 10.5, 1 H, H−C(4)). – ^{13}C-NMR. ($CDCl_3$): 93.96 (C(3)); 73.56 (C(4)); 36.43, 21.89, 18.52, 13.97, 10.62 and 0.22.

Data of 2-nitro-3-trimethylsilyloxyoctane (**37a**). GP VII; yield 90%, b.p. 70°/0.07 Torr. – IR.: 1550 (NO_2), 1255, 840. – ^{1}H-NMR. (300 MHz, C_6D_6): 0.06 (*s*, 9 H, $(H_3C)_3Si$); 0.8–0.9 (*t*, *J* = 6,

3 H, 3 H–C(8)); 1.0–1.3 (overlapping *d* and *m*, 11 H, 3 H–C(1) and 4 CH_2); 3.9–4.0 (*d*×*qa*, *J* = 3 and 6.5, 1 H, H–C(2)); 4.2–4.25 (*d*×*d*×*d*, *J* = 3.5, 5 and 7.5, 1 H, H–C(3)). – ^{1}H-NMR. ($CDCl_3$) (300 MHz): 4.25–4.3 (*m*, 1 H, H–C(3)); 4.4–4.45 (*d*×*qa*, *J* = 3.5 and 6.5, 1 H, H–C(2)) (other signals are not included here). – ^{13}C-NMR. ($CDCl_3$): 86.22 (C(2)); 74.06 (C(3)); 34.66, 31.68, 25.23, 22.51, 13.94, 11.81 and 0.14.

Data of 2-nitro-1-phenyl-1-trimethylsilyloxybutane (**38a**/**38b**). GP VII; yield 85%, b.p. 100°/0.2 Torr. – IR.: 1550 (NO_2), 1255, 845, 700. – ^{1}H-NMR. (C_6D_6) (300 MHz): −0.05 and −0.03 (2 *s*, 9 H, $(H_3C)_3Si$); 0.5 and 0.65 (2 *t*, *J* = 6, 3 H, 3 H–C(4)); 1.6–1.75 (*m*) and 2.0–2.15 (*m*) (2 H, 2 H–C(3)); 4.35 (*d*×*d*×*d*, *J* = 3, 6 and 11, 1 H, H–C(2)); 4.95 (*d*, *J* = 9.5, 0.17 H) and 5.15 (*d*, *J* = 6, 0.83 H) (H–C(1)); 7.0–7.25 (*m*, 5 H, arom. H). *threo/erythro* = 1:4.9. – ^{13}C-NMR. ($CDCl_3$): 139.92, 128.79, 128.52, 126.49, 95.87 (C(2)); 76.00 (C(1)); 21.77, 10.49 and −0.16.

10. Preparation of (*t*-butyl)dimethylsilyl ester of 1-*aci*-nitroalkanes (see *Scheme 8*). – The silyl-nitronates were prepared from the corresponding nitroalkanes on 20–50 mmol scale according to the published procedure [14].

*Preparation of (t-butyl)dimethylsilyl ester of 1-*aci*-nitroethane* (**40**). Yield 68%, b.p. 30°/0.05 Torr. – IR.: 1620 (C=N), 1250, 1110, 1030, 850, 790. – ^{1}H-NMR. ($CDCl_3$): 0.25 (*s*, 6 H, $(H_3C)_2Si$); 0.9 (*s*, 9 H, $(H_3C)_3CSi$); 1.85 (*d*, *J* = 6, 3 H, 3 H–C(2)); 6.15 (*qa*, *J* = 6, 1 H, H–C(1)).

*Data of (t-butyl)dimethylsilyl ester of 1-*aci*-nitropropane* (**41**). Yield 82%, b.p. 100°/0.1 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.2 (*s*, 6 H, $(H_3C)_2Si$); 0.85 (*s*, 9 H, $(H_3C)_3CSi$); 1.0 (*t*, *J* = 7, 3 H, 3 H–C(3)); 2.25 (*qi*, *J* = 7, 2 H, 2 H–C(2)); 6.05 (*t*, *J* = 7, 1 H, H–C(1)).

*Data of (t-butyl)dimethylsilyl ester of (−)-(S)-1-*aci*-nitro-2-methylbutane* (**42**). Yield 62%, b.p. 110°/0.03 Torr, $[\alpha]_D^{25} = +11.9°$ (*c* = 2, $CHCl_3$). – IR.: 1615 (C=N), 1250, 850, 780. – ^{1}H-NMR. ($CDCl_3$): 0.3 (*s*, 6 H, $(H_3C)_2Si$); 0.8–1.1 (*m*, 15 H, $(H_3C)_3CSi$, H_3C–C(2) and 3 H–C(4)); 1.26–1.7 (*m*, 2 H, 2 H–C(3)); 2.6 (*sept*, *J* = 7.5, 1 H, H–C(2)); 5.93 (*d*, *J* = 7.5, 1 H, H–C(1)).

$C_{11}H_{25}NO_2Si$ (231.41) Calc. C 75.09 H 10.89 N 6.05% Found C 75.24 H 10.89 N 5.88%

*Data of the (t-butyl)dimethylsilyl esters of 1-*aci*-nitrohexane* (**43**), *of 1-*aci*-nitrooctane* (**44**), *and of methyl 4-*aci*-nitrobutanoate* (**45**). See [14].

Large-scale preparation of **45**. To a cold (−40°) solution of diisopropylamine (15 ml, 105.8 mmol) in THF (200 ml) a solution of BuLi in hexane (66 ml, 104.3 mmol) was added dropwise. The mixture was stirred for 30 min and then cooled to −78°. This cold solution was added *via* a *Teflon* tube to a precooled (−78°) solution of methyl 4-nitrobutanoate (13 ml, 104 mmol) in THF (150 ml) and the light-yellow suspension was stirred at −70° for 15 min. A solution of (*t*-butyl)dimethylsilyl chloride (17.6 g, 116.8 mmol) in THF (20 ml) was added to the mixture which was then allowed to warm up to r.t. over a period of 16 h. The solvent was flash-evaporated (oil pump, 20–100 Torr) and pentane (400 ml) was added to the residual liquid. After shaking, the suspension was filtered under argon, the filtrate was evaporated (oil pump, 50 Torr) and the residual liquid was distilled under reduced pressure through a 10 cm *Vigreux*-column to obtain a light-yellow liquid (17 g, 62.6%), b.p. 82°/0.03 Torr, *d* = 1.007. – IR.: 1740 ($COOCH_3$), 1615 (C=N), 1250, 830, 790. – ^{1}H-NMR. ($CDCl_3$): 0.3 (*s*, 6 H, $(H_3C)_2Si$); 0.96 (*s*, 9 H, $(H_3C)_3CSi$); 2.45–2.65 (*m*, 4 H, 2 H–C(2) and 2 H–C(3)); 3.68 (*s*, 3 H, OCH_3); 6.05–6.3 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. ($CDCl_3$): 172.10 (C(1)); 114.77 (C(4)); 51.30 (OCH_3); 29.31, 27.49, 25.72, 25.54, 21.73, 17.45, −4.35 and −4.78.

$C_{11}H_{23}NO_4Si$ (261.39) Calc. C 50.54 H 8.87 N 5.36% Found C 50.67 H 8.80 N 5.28%

11. Fluoride-catalyzed condensation of (*t*-butyl)dimethylsilyl nitronates with aldehydes. – *General procedure X* (GP X). A stirred solution of the silyl nitronate (50 mmol) and the aldehyde (50 mmol) in THF (70 ml) was cooled to −78°. To this solution was added a 0.4 M solution of dried Bu_4NF in THF (12.5 ml, 5 mmol), freshly prepared by stirring the $Bu_4NF \cdot 3\,H_2O$ (6 mmol) with activated 4 Å molecular sieves (6 g) in THF (15 ml) for 12 h. The mixture was allowed to warm to 20° over 15 h and then poured into hexane/water. The hexane layer was separated and the aqueous layer was extracted with hexane. The extracts were washed with water and sat. aq. NaCl-solution and dried ($MgSO_4$). Evaporation, followed by careful bulb-to-bulb distillation gave the silylated nitroaldol and a lower boiling fraction which contained non-silylated nitroaldol. If the silylated nitroaldol could not be completely freed from the unsilylated nitroaldol by distillation, further purification was achieved by column chromatography over silica gel (30 g/1 g of the product) using 10% ether in pentane as eluant.

General procedure XI (GP XI). To a cold (temperature as mentioned in *Scheme 9*) solution of **45** (2.6 ml, 10 mmol) in THF (20 ml) was added the aldehyde (10 mmol) followed by Bu_4NF-solution in THF (2 ml, 1 mmol)[27]). After stirring the mixture at the specified temp. (see *Scheme 9*) for 3.5–4 h (exception: the reaction at −20° was carried out for 20 h) it was poured into pentane (80 ml). The organic phase was separated and washed with water (3 × 50 ml), dried ($MgSO_4$) and the solvent was distilled off in a rotary evaporator. The crude product was freed from lower-boiling impurities by exposing it to high vacuum (10^{-5} Torr) for 1 h at r.t. Assuming the unsilylated nitroaldol constituted about 10% of the crude product, it was subjected to silylation (GP IV)[28]). The completely silylated crude product was bulb-to-bulb-distilled (high vacuum) to obtain the pure product. The ratio of the diastereomers were determined by GC. analysis and during silylation there was no change in the diastereomeric ratio.

Data of 3-(t-butyl)dimethylsilyloxy-4-nitrohexane (**13a**). GP X; Yield 50%, b.p. 100°/0.1 Torr. – IR.: 1550 (NO_2), 1260, 1120, 840, 780. – ^{1}H-NMR. ($CDCl_3$): 0.05 (*s*, 6 H, $(H_3C)_2Si$); 0.75–1.1 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(1) and 3 H–C(6)); 1.35–2.3 (*m*, 4 H, 2 H–C(2) and 2 H–C(5)); 4.0 (*qa*, *J* = 5.5, 1 H, H–C(3)); 4.35 (*d* × *d* × *d*, *J* = 4, 5.5 and 10, 1 H, H–C(4)). – ^{13}C-NMR. ($CDCl_3$): as of the sample from GP VII.

This compound was reduced (GP I) to erythro-*2-(t-butyl)dimethylsilyloxy-1-ethyl-butylamine* (**23a**). Yield 87%. – ^{1}H-NMR. ($CDCl_3$): identical with that described in *Sect. 6* and *7*, above. – ^{13}C-NMR. ($CDCl_3$): 76.36 (C(3)); 56.34 (C(4)); 25.05, 24.77, 22.74, 17.20, 10.34, 9.46 and −5.33. Data identical with those of sample from independent synthesis, see *Section 6*, above.

Data of 4-(t-butyl)dimethylsilyloxy-3-nitroheptane (**14a**). GP X; yield 64%, b.p. 70–80°/0.003 Torr. – IR.: 1545 (NO_2), 1460, 1255, 1120, 835, 780. – ^{1}H-NMR. ($CDCl_3$): 0.02 (*s*, 6 H, $(H_3C)_2Si$); 0.75–1.1 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(1) and 3 H–C(7)); 1.3–1.65 (*m*, 4 H, 2 CH_2); 1.7–2.3 (*m*, 2 H, 2 H–C(2)); 3.7–4.15 (*m*, 1 H, H–C(4)); 4.15–4.55 (*m*, 1 H, H–C(3)). – ^{13}C-NMR. ($CDCl_3$): 93.16 (C(3)); 73.25 (C(4)), 36.23, 25.59, 22.38, 17.92, 13.87, 10.55, −4.68 and −5.07. *Cf.* the spectra of the same compound from GP VII, *Section 9*, above.

Data of 3-(t-butyl)dimethylsilyloxy-2-nitrooctane (**15a**). GP X; yield 69%, b.p. 50°/0.005 Torr. – IR.: 1550 (NO_2), 1250, 840, 780. – ^{1}H-NMR. (CCl_4): 0.0 and 0.05 (2 *s*, 6 H, $(H_3C)_2Si$); 0.8–1.05 (*m*, 12 H, $(H_3C)_3CSi$ and 3 H–C(8)); 1.1–1.65 (*m*, 11 H, 3 H–C(1) and 4 CH_2); 4.0–4.55 (*m*, 2 H, H–C(2) and H–C(3)). – ^{13}C-NMR. ($CDCl_3$): 85.44 (C(2)); 73.69 (C(3)); 34.62, 31.66, 25.60, 24.79, 22.37, 17.87, 13.75, 11.22, −4.62 and −5.26. *Cf.* the spectra of the same compound from GP VII, *Section 9*, above.

Data of 4-(t-butyl)dimethylsilyloxy-3-nitrononane (**16a**). GP X; yield 67%, b.p. 100–110°/0.005 Torr. – IR.: 1550 (NO_2), 1460, 1255, 840, 780. – ^{1}H-NMR. ($CDCl_3$): 0.02 (*s*, 6 H, $(H_3C)_2Si$); 0.7–1.1 (*m*, 15 H, $(H_3C)_3CSi$, 3 H–C(1) and 3 H–C(9)); 1.1–2.7 (*m*, 10 H, 2 H–C(2) and 4 CH_2); 3.8–4.2 (*m*, 1 H, H–C(4)); 4.2–4.45 (*m*, 1 H, H–C(3)). – ^{13}C-NMR. ($CDCl_3$): 93.19 (C(3)); 73.50 (C(4)); 34.09, 31.72, 25.65, 24.25, 22.38, 21.49, 17.92, 13.79, 10.62, −4.56 and −4.96. *Cf.* the spectra of the same compound from GP VII, *Section 9*, above.

Data of 4-(t-butyl)dimethylsilyloxy-5-nitrododecane (**17a**). GP X; yield 31%, b.p. 110–135°/0.005 Torr. – ^{1}H-NMR. ($CDCl_3$): 0.03 (*s*, 6 H, $(H_3C)_2Si$); all other signals are as described for **17**. – ^{13}C-NMR. ($CDCl_3$): 91.61 (C(5)); 73.40 (C(4)); 36.22, 31.60, 29.01, 28.86, 28.13, 26.19, 25.79, 25.64, 22.48, 17.97, 13.91, −4.61 and −4.97.

Data of 1-(t-butyl)dimethylsilyloxy-2-nitro-1-phenylbutane (**22a/22b**). GP X; yield 71%, b.p. 105–110°/0.003 Torr. – IR.: 1550 (NO_2), 1260, 1095, 840, 780, 700. – ^{1}H-NMR. ($CDCl_3$): −0.28, −0.2, 0.0 and 0.03 (4 *s*, 6 H, $(H_3C)_2Si$, two isomers); 0.72–1.03 (overlapping *t* and 2 *s*, 12 H, $(H_3C)_3CSi$ and 3 H–C(4)); 1.7–2.4 (*m*, 2 H, 2 H–C(3)); 4.3–4.7 (*m*, 1 H, H–C(2)); 4.9 (*d*, *J* = 9) and 5.1 (*d*, *J* = 6), (1 H, H–C(1)); 7.3 (*s*, 5 H, arom. H). *threo/erythro* = 1:3.5. *Cf.* the spectra of the same compound from GP VII, *Section 9*, above.

---

[27]) Bu_4NF-solution was prepared as follows: To a mixture of $Bu_4NF \cdot 3\,H_2O$ (3.2 g, 10.1 mmol) and molecular sieves (14 g, 4 A) in a serum-capped flask was added THF (20 ml). The suspension was stirred overnight and then stored in deep freeze. The clear supernatant liquid was withdrawn as and when required.

[28]) The silylation was carried out at 8° (instead of 0–1°) using 8 ml CH_2Cl_2 per gram of the crude product.

Data of 1-(t-butyl)dimethylsilyloxy-1-(3'-methoxyphenyl)-2-nitrobutane (**46a/46b**). GP X; yield 59%, b.p. 120°/10^{-5} Torr. – IR.: 1550 (NO_2), 1260, 840, 780. – ^{1}H-NMR. (CCl_4): −0.3, −0.23, −0.09 and −0.03 (4 *s*, 6 H, $(H_3C)_2Si$, two isomers); 0.65–0.95 (overlapping *t* and 2 *s*, 12 H, $(H_3C)_3CSi$ and 3 H–C(4)); 1.45–2.3 (*m*, 2 H, 2 H–C(3)); 3.71 (*s*, 3 H, OCH_3); 4.13–4.4 (*m*, 1 H, H–C(2)); 4.78 (*d*, *J* = 9, 0.2 H, H–C(1), *threo*); 5.03 (*d*, *J* = 6, 0.8 H, H–C(1), *erythro*); 6.6–7.3 (*m*, 5 H, arom. H). *threo/erythro* = 1:4. – ^{13}C-NMR. ($CDCl_3$): 159.78, 141.65, 129.76, 129.54, 119.73, 118.90, 114.39, 114.01, 112.71, 112.15; 96.64 (C(2), *threo*); 95.94 (C(2), *erythro*); 77.07 (C(1), *threo*); 76.12 (C(1), *erythro*); 55.28 (OCH_3); 25.75, 25.58, 23.66, 21.20, 18.17, 10.60, 10.27, −4.71, −5.40 and −5.64.

$C_{17}H_{29}NO_4Si$ (339.51) Calc. C 60.14 H 8.61 N 4.13% Found C 60.44 H 8.71 N 4.07%

Data of 1-(t-butyl)dimethylsilyloxy-2-nitro-1-phenylheptane (**47a/47b**). GP X; yield 53%, b.p. 130–140°/0.003 Torr. – IR.: 1550 (NO_2), 1260, 1100, 835, 780, 700. – ^{1}H-NMR. ($CDCl_3$): −0.35, −0.25, −0.06 and 0.0 (4 *s*, 6 H, $(H_3C)_2Si$, two isomers); 0.65–1.0 (*m*, 12 H, $(H_3C)_3CSi$ and 3 H–C(7)); 1.0–2.3 (*m*, 8 H, 4 CH_2); 4.3–4.65 (*m*, 1 H, H–C(2)); 4.9 (*d*, *J* = 9, *threo*) and 5.05 (*d*, *J* = 6, *erythro*) (1 H, H–C(1)); 7.3 (*s*, 5 H, arom. H). *threo/erythro* = 1:5.7.

$C_{19}H_{33}NO_3Si$ (351.58) Calc. C 64.91 H 9.46 N 3.98% Found C 65.10 H 9.46 N 4.02%

Data of 4-(t-butyl)dimethylsilyloxy-5-methyl-3-nitrooctane (**48** and **49**). GP X, yield 56%, b.p. 120°/0.01 Torr. – IR.: 1550 (NO_2), 1250, 840, 780. – ^{1}H-NMR. ($CDCl_3$): 0.06 (br. *s*, 6 H, $(H_3C)_2Si$); 0.75–2.1 (*m*, 25 H, $(H_3C)_3CSi$, 3 H–C(1), 2 H–C(2), H–C(5), H_3C–C(5), 2 H–C(6), 2 H–C(7) and 3 H–C(8)); 3.85–4.03 (*m*, 1 H); 4.23–4.53 (*m*, 1 H). – ^{13}C-NMR. ($CDCl_3$): 92.40 (C(3)); 91.73 (C(3)); 77.41 (C(4)); 76.97 (C(4)); 38.39, 37.32, 35.27, 34.24, 25.86, 23.13, 22.58, 20.51, 18.23, 18.14, 15.05, 14.16, 14.00 and 10.53. No $Si(CH_3)_2$ on scale!

$C_{15}H_{33}NO_3Si$ (303.52) Calc. C 59.36 H 10.96 N 4.61% Found C 59.23 H 10.83 N 4.62%

H_2/Raney-*nickel reduction* (GP I) *of the mixture of* **48** and **49** gave *2-(t-butyl)dimethylsilyloxy-1-ethyl-3-methyl-hexylamine:* yield 88%, b.p. 130°/0.005 Torr. – IR.: 1250, 1060, 840, 780. – ^{1}H-NMR. ($CDCl_3$): 0.05 (*s*, 6 H, $(H_3C)_2Si$); 0.7–1.75 (*m*, 27 H, $(H_3C)_3CSi$, 3 H–C(2'), 2 H–C(1'), H–C(3), H_3C–C(3), 2 H–C(4), 2 H–C(5), 3 H–C(6) and NH_2); 2.4–2.75 (*m*, 1 H, H–C(1)); 3.25–3.45 (*m*, 1 H, H–C(2)).

Data of (3S,4R,5S)- and (3R,4S,5S)-3-(t-butyl)dimethylsilyloxy-5-methyl-4-nitroheptane (**50** and **51**): GP X, yield 50%, b.p. 110°/0.1 Torr. – IR.: 1550 (NO_2), 1255, 840, 780. – ^{1}H-NMR. ($CDCl_3$): 0.05 and 0.06 (2 *s*, 6 H, $(H_3C)_2Si$); 0.7–2.3 (*m*, 23 H, $(H_3C)_3CSi$, 3 H–C(1), 2 H–C(2), H–C(5), H_3C–C(5), 2 H–C(6) and 3 H–C(7)); 3.8–4.16 (*m*, 1 H, H–C(3)); 4.25–4.53 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. ($CDCl_3$): 96.43 (C(4)); 94.42 (C(4)); 71.91 (C(3)); 71.04 (C(3)); 34.57, 34.42, 25.95, 25.63, 25.20, 25.09, 24.41, 17.91, 14.99, 14.59, 10.94, 10.49, 9.77, 8.78, −4.48, −4.66 and −4.77.

Reduction (GP I) *of the above mixture of* **50** *and* **51** furnished a mixture of *(3S,4R,5S)-* and *(3R,4S,5S)-2-(t-butyl)-dimethylsilyloxy-1-[(1'-methyl)propyl]butylamine*, yield 70%, b.p. 110°/0.005 Torr. – IR.: 3300 (NH_2), 1250, 840. – ^{1}H-NMR. ($CDCl_3$): 0.03 (*s*, 6 H, $(H_3C)_2Si$); 0.75–2.1 (*m*, 25 H, $(H_3C)_3CSi$, 3 H–C(4), 2 H–C(3), H–C(1'), H_3C–C(1'), 2 H–C(2'); 3 H–C(3') and NH_2); 2.4–2.7 (*m*, 1 H, H–C(1)); 3.5–3.75 (*m*, 1 H, H–C(2)).

Data of methyl 5-(t-butyl)dimethylsilyloxy-4-nitroheptanoate (**52**). GP XI, yield 49% (yields were unaffected by reaction temperature), b.p. 100°/$4 \cdot 10^{-6}$ Torr. – IR.: 1740 ($COOCH_3$), 1550 (NO_2), 1260, 840, 780. – ^{1}H-NMR. (CCl_4)[29]: −0.07 and −0.03 (2 *s*, 6 H, $(H_3C)_2Si$); 0.75–1.1 (*m*, 12 H, $(H_3C)_3CSi$ and 3 H–C(7)); 1.33–1.77 (*qi*, 2 H, 2 H–C(6)); 1.85–2.6 (*m*, 4 H, 2 H–C(2) and 2 H–C(3)); 3.56 (*s*, 3 H, OCH_3); 3.95–4.2 (*m*, 1 H, H–C(5)); 4.3–4.55 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. ($CDCl_3$)[29]: 172.51 (C(1)); 89.55 (C(4)); 75.05 (C(5)); 51.42 (OCH_3); 29.97, 27.27, 25.53, 22.05, 17.78, 9.04, −4.72 and −5.30.

$C_{14}H_{29}NO_5Si$ (319.47) Calc. C 52.63 H 9.15 N 4.38% Found C 52.56 H 8.99 N 4.53%

threo/erythro-Ratios were determined by GC. and ratios at different temperatures are indicated in *Scheme 9*.

Reduction (GP II) *of* **52**[29]) gave a mixture of *methyl 4-amino-5-(t-butyl)dimethylsilyloxyheptanoate* (**55**, R = C_2H_5) and its lactam, *5-(1'-(t-butyl)dimethylsilyloxy)propyl-2-pyrrolidone* (**56**). Lactamization was

[29]) Sample from the reaction at lowest temperature mentioned in *Scheme 9*.

complete upon heating overnight at 60° and further purified by bulb-to-bulb distillation: yield 76%, b.p. 110°/5 · 10^{-6} Torr. – IR.: 3210 (NH), 3100, 1695, 1460, 1255, 1100, 840, 775. – ^{1}H-NMR. ($CDCl_3$): −0.03 (*s*, 6 H, $(H_3C)_2Si$); 0.65–1.15 (overlapping *s* and *t*, 12 H, $(H_3C)_3CSi$ and 3 H–C(3′)); 1.4 (*qi*, *J* = 6, 2 H, 2 H–C(2′)); 1.7–2.4 (*m*, 4 H, 2 H–C(3) and 2 H–C(4)); 3.35–3.75 (*m*, 2 H, H–C(5) and H–C(1′)); 7.35 (br. *s*, 1 H, NH). – ^{13}C-NMR. ($CDCl_3$): 178.98 (C(2)); 76.50 (C(1′), *threo*); 75.18 (C(1′), *erythro*); 57.93 (C(5), *erythro*); 57.62 (C(5), *threo*); 30.25, 26.34, 25.81, 23.18, 20.87, 17.99, 9.64, 8.76, −4.28 and −4.51. *threo/erythro* = 1:12 (p.h.).

$C_{13}H_{27}NO_2Si$ (257.45) Calc. C 60.65 H 10.57 N 5.44% Found C 60.70 H 10.71 N 5.46%

Desilylation (GP IX) *with LAH* resulted in concomitant reduction of the lactam ring to furnish *2-(1′-hydroxy-1′-propyl)pyrrolidine* (**66**) as a white solid: yield 86%, sublimed at 50°/0.05 Torr, m.p. 81°. The substance absorbed CO_2 and moisture very readily and hence was characterized as its oxalate: m.p. 194–195° (crystallized from methanol/ether). – ^{1}H-NMR. (CD_3OD): 0.98 (*t*, *J* = 7.5, 3 H, 3 H–C(3′)); 1.49 (*qi*, *J* = 7.5, 2 H, 2 H–C(2′)); 1.8–2.3 (*m*, 4 H, 2 H–C(3) and 2 H–C(4)); 3.1–3.9 (*m*, 4 H, H–C(2), 2 H–C(5) and H–C(1′)). – ^{13}C-NMR. (CH_3OD): 166.82 (COO); 73.01 (*threo*), 71.21 (*erythro*), 65.96 (*threo*), 64.73 (*erythro*), 46.84 (*erythro*), 46.31 (*threo*), 28.60, 28.39, 24.96, 24.31, 10.47, 9.97. *threo/erythro* = 1:7 (p.h.).

$(C_7H_{15}NO)_2 \cdot (CO_2H)_2$ (348.43) Calc. C 55.15 H 9.26 N 8.04% Found C 54.65 H 9.14 N 7.87%

Data of methyl 5-(t-butyl)dimethylsilyloxy-4-nitrodecanoate (**53**). GP XI; yield 50%, b.p. 115°/ 7 · 10^{-6} Torr. – IR.: 1740 ($COOCH_3$), 1550 (NO_2), 1255, 835, 775. – ^{1}H-NMR. (CCl_4): −0.03 and 0.01 (2 *s*, 6 H, $(H_3C)_2Si$); 0.75–1.15 (br. *s*, 12 H, $(H_3C)_3CSi$ and 3 H–C(10)); 1.15–1.75 (br. *s*, 8 H, 4 CH_2); 1.85–2.65 (*m*, 4 H, 2 H–C(2) and 2 H–C(3)); 3.62 (*s*, 3 H, OCH_3); 4.0–4.3 (*m*, 1 H, H–C(5)); 4.3–4.6 (*m*, 1 H, H–C(4)). – ^{13}C-NMR. ($CDCl_3$): 172.75 (C(1)); 90.08 (C(4)); 74.11 (C(5)); 51.65 (OCH_3); 34.52, 31.66, 30.18, 25.68, 24.60, 22.41, 22.07, 17.92, 13.83, −4.55 and −5.11.

$C_{17}H_{35}NO_5Si$ (361.55) Calc. C 56.47 H 9.76 N 3.87% Found C 56.22 H 9.59 N 4.10%

For *threo/erythro* ratios, as determined by GC., see *Scheme 9*.

Data of methyl 5-(t-butyl)dimethylsilyloxy-4-nitro-5-phenylpentanoate (**54**). GP XI, yield 45% (independent of reaction temp.), b.p. 145°/3 · 10^{-5} Torr. – IR.: 1740 ($COOCH_3$), 1550 (NO_2), 1255, 1095, 840, 780, 705. – ^{1}H-NMR. ($CDCl_3$) (300 MHz)[29]: −0.28, −0.18, −0.03, and 0.02 (4 *s*, 6 H, $(H_3C)_2$ Si): 0.79 and 0.89 (2 *s*, 9 H, $(H_3C)_3CSi$); 2.15–2.5 (*m*, 4 H, 2 H–C(2) and 2 H–C(3)); 3.59 (*s*, 3 H, OCH_3); 4.62 (*d* × *d*, *d*, *J* = 2.5, 5 and 10.5, 0.2 H, H–C(4)); 4.71 (*d* × *d* × *d*, *J* = 3.3, 9.3 and 11.5, 0.8 H, H–C(4)); 4.94 (*d*, *J* = 9.3, 0.17 H, H–C(5), *threo*); 5.25 (*d*, *J* = 5, 0.83 H, H–C(5), *erythro*); 7.34 (*s*, 5 H, arom. H). *threo/erythro* = 1:4.9 (see *Scheme 9* for *threo/erythro*-ratios at 10°). – ^{13}C-NMR. ($CDCl_3$)[29]: 172.12 (C(1)); 171.58 (C(1)); 139.32, 138.78, 128.84, 128.62, 128.32, 127.16, 126.20, 93.57 (C(4), *threo*); 92.47 (C(4), *erythro*); 76.89 (C(5), *threo*); 76.01 (C(5), *erythro*); 51.34 (OCH_3); 30.00, 29.66, 25.50, 25.30, 25.01, 22.04, 17.90, 17.74, −5.01, −5.74 and −5.92.

$C_{18}H_{29}NO_5Si$ (367.52) Calc. C 58.83 H 7.95 N 3.81% Found C 58.79 H 8.08 N 3.96%

Reduction (GP II) *of* **54**[29]) gave a mixture of *methyl 4-amino-5-(t-butyl)dimethylsilyloxy-5-phenylpentanoate* (**55**, R = C_6H_5) and *5-(1′-(t-butyl)dimethylsilyloxy-1′-phenyl)methyl-2-pyrrolidone* (**57**). Heating of the crude product at 60° for 6 h resulted in complete conversion of the amino ester **55** to **57** which was purified by bulb-to-bulb distillation: yield 80%, b.p. 145°/2 · 10^{-6} Torr. – IR. ($CHCl_3$): 3440 (NH), 1690, 1255, 1095, 1070, 840. – ^{1}H-NMR. (CCl_4): −0.13, −0.1 and 0.1 (3 *s*, 6 H, $(H_3C)_2Si$); 0.93 and 0.95 (2 *s*, 9 H, $(H_3C)_3CSi$); 1.55–2.5 (*m*, 4 H, 2 H–C(3) and 2 H–C(4)); 3.5–3.85 (*m*, 1 H, H–C(5)); 4.5 (*d*, *J* = 6, 0.22 H, H–C(1′), *threo*); 4.75 (*d*, *J* = 3, 0.78 H, H–C(1′), *erythro*); 7.3 (*s*, 5 H, arom. H); 7.75 and 8.2 (2 br. *s*, 1 H, NH). *threo/erythro* = 1:3.5. – ^{13}C-NMR. ($CDCl_3$): 178.87 (C(2)); 178.09 (C(2)); 140.81, 140.44, 128.62, 128.09, 127.92, 127.56, 127.13, 126.66, 126.34, 125.80, 125.50, 76.74 (C(1′)), 60.70 (C(5)); 29.86, 25.91, 25.65, 22.73, 21.13, 17.89, −4.76, −4.94 and −5.25.

$C_{17}H_{27}NO_2Si$ (305.50) Calc. C 66.84 H 8.91 N 4.58% Found C 66.77 H 8.89 N 4.75%

REFERENCES

[1] *D. Seebach, E. W. Colvin, F. Lehr & Th. Weller*, Chimia *33*, 1 (1979).

[2] *D. Seebach, A. K. Beck, F. Lehr, Th. Weller & E. W. Colvin*, Angew. Chem. *93*, 422 (1981); *ibid.* Int. Ed. *20*, 397 (1981).

[3] «Methoden der Organischen Chemie», (Houben-Weyl), Vol. X/1, Georg Thieme Verlag, Stuttgart 1971.

[4] *R. G. Coombes*, in 'Comprehensive Organic Chemistry' (Eds. D.H.R. Barton & W.D. Ollis), Vol. 2, pg. 303, Pergamon, Oxford 1979.

[5] *F. Lehr, J. Gonnermann & D. Seebach*, Helv. Chim. Acta *62*, 2258 (1979).

[6] *F. Lehr*, Dissertation No. 6356, ETH-Zürich 1979.

[7] *E. W. Colvin & D. Seebach*, J. Chem. Soc., Chem. Commun. *1978*, 689.

[8] *C. A. Sprang & E. F. Degering*, J. Am. Chem. Soc. *64*, 1063 (1942).

[9] a) *M. Th. Maurette, A. Gaset, R. Mathis & A. Lattes*, Bull. Soc. Chim. Fr. *1975*, 398; *C. A. Kingsbury & D. C. Best*, J. Org. Chem. *32*, 6 (1967); *G. Drefahl, G. Heublein & E. Linke*, Z. Chem. *8*, 174 (1968); b) *B. Renger & D. Seebach*, Chem. Ber. *110*, 2334 (1977).

[10] *J. Buter, S. Wassenaar & R. M. Kellogg*, J. Org. Chem. *37*, 4045 (1972).

[11] *J.-E. Bäckvall, K. Oshima, R. E. Palermo & K. B. Sharpless*, J. Org. Chem. *44*, 1953 (1979).

[12] *T. Mukhopadhyay & D. Seebach*, Helv. Chim. Acta *65*, 385 (1982).

[12] *D. Seebach & R. Naef*, Helv. Chim. Acta *64*, 2704 (1981).

[14] *E. W. Colvin, A. K. Beck, B. Bastani, D. Seebach, Y. Kai & J. D. Dunitz*, Helv. Chim. Acta *63*, 697 (1980).

[15] *H. Gerlach & P. Künzler*, Helv. Chim. Acta *61*, 2503 (1978).

[16] *R. Noyori, K. Yokoyama, J. Sakata, I. Kuwajima, E. Nakamura & M. Shimizu*, J. Am. Chem. Soc. *99*, 1265 (1977).

[17] *J. H. Clark*, J. Chem. Soc., Chem. Commun. *1978*, 789.

[18] *S. Colonna, A. Re, G. Gelbard & E. Cesarotti*, J. Chem. Soc., Perkin I *1979*, 2248.

[19] *D. Clement, F. Damm & J. M. Lehn*, Heterocycles *5*, 477 (1976).

[20] *D. J. Cram & F. A. Abd Elhafez*, J. Am. Chem. Soc. *74*, 5828 (1952); *N. T. Anh & O. Eisenstein*, Nouveau J. Chimie *1*, 61 (1977); *N. T. Anh*, Topics in Curr. Chem. *88*, 145 (1980).

[21] a) *E. J. Corey, H. Cho, Ch. Rücker & D. H. Hua*, Tetrahedron Lett. *1981*, 3455; b) *E. J. Corey & A. Venkateswarlu*, J. Am. Chem. Soc. *94*, 6190 (1972).

[22] *J. W. Cornforth, R. H. Cornforth & K. K. Mathew*, J. Chem. Soc. *1959*, 112.

[23] *D. Seebach & D. Wasmuth*, Helv. Chim. Acta *63*, 197 (1980); *M. Züger, Th. Weller & D. Seebach*, Helv. Chim. Acta *63*, 2005 (1980); *D. Wasmuth, D. Arigoni & D. Seebach*, Helv. Chim. Acta *65*, 344 (1982).

[24] *D. Seebach & D. Wasmuth*, Angew. Chem. *93*, 1007 (1981); *ibid.* Int. Ed. *20*, 971 (1981).

[25] *D. J. Cram & D. R. Wilson*, J. Am. Chem. Soc. *85*, 1245 (1963).

[26] *W. C. Still & J. H. McDonald, III*, Tetrahedron Lett. *1980*, 1031; *W. C. Still & J. A. Schneider*, Tetrahedron Lett. *1980*, 1035.

[27] *D. Seebach & J. Golinski*, Helv. Chim. Acta *64*, 1413 (1981).

[28] *R. Amstutz, W. B. Schweizer, D. Seebach & J. D. Dunitz*, Helv. Chim. Acta *64*, 2617 (1981); *D. Seebach, R. Amstutz & J. D. Dunitz*, Helv. Chim. Acta *64*, 2622 (1981).

[29] *H. E. Zimmerman & M. D. Traxler*, J. Am. Chem. Soc. *79*, 1920 (1957); *J.-E. Dubois & M. Dubois*, Tetrahedron Lett. *1967*, 4215.

[30] *C. H. Heathcock*, Science *214*, 395 (1981); *idem.* Acc. Chem. Res., in print; *D. A. Evans, J. M. Takacs, L. R. McGee, M. D. Ennis, D. J. Mathre & J. Bartroli*, Pure Appl. Chem. *53*, 1109 (1981); *R. Schmierer, G. Grotemeier, G. Helmchen & A. Selim*, Angew. Chem. *93*, 209 (1981); *ibid.* Int. Ed. *20*, 207 (1981).

[31] *H. Wollweber & R. Hiltmann*, Arch. Pharm. *306*, 284 (1973); *N. Ardabilchi, A. O. Fitton, J. R. Frost, F. K. Oppong-Boachie, A. H. b. A. Hadi & A. b. M. Sharif*, J. Chem. Soc., Perkin I *1979*, 539.

[32] *Th. Weller, D. Seebach, R. E. Davis & B. B. Laird*, Helv. Chim. Acta *64*, 736 (1981).

[33] *D. Seebach & D. Enders*, Angew. Chem. *87*, 1 (1975); *ibid.* Int. Ed. *14*, 15 (1975); *D. Enders, T. Hassel, R. Pieter, B. Renger & D. Seebach*, Synthesis *1976*, 548; *B. Renger, H.-O. Kalinowski & D. Seebach*, Chem. Ber. *110*, 1866 (1977); *D. Seebach, W. Wykypiel, W. Lubosch & H.-O. Kalinowski*, Helv. Chim. Acta *61*, 3100 (1978).

[34] *D. Seebach, W. Lubosch & D. Enders*, Chem. Ber. *109*, 1309 (1976); *D. Seebach & W. Lubosch*, Angew. Chem. *88*, 339 (1976); *ibid.* Int. Ed. *15*, 313 (1976); *R. Schlecker, D. Seebach & W. Lubosch*, Helv. Chim. Acta *61*, 512 (1978); *W. Lubosch & D. Seebach*, Helv. Chim. Acta *63*, 102 (1980); *J.-J. Lohmann, D. Seebach, M.A. Syfrig & M. Yoshifuji*, Angew. Chem. *93*, 125 (1981); *ibid.* Int. Ed. *20*, 128 (1981); *W. Wykypiel, J.-J. Lohmann & D. Seebach*, Helv. Chim. Acta *64*, 1337 (1981); *P. Beak & D.B. Reitz*, Chem. Rev. *78*, 275 (1978); *D.B. Reitz, P. Beak & A. Tse*, J. Org. Chem. *46*, 4316 (1981).

[35] *D. Seebach & M. Yoshifuji*, Helv. Chim. Acta *64*, 643 (1981).

[36] *T. Hassel & D. Seebach*, Helv. Chim. Acta *61*, 2237 (1978); *idem.* Angew. Chem. *91*, 427 (1979); *ibid.* Int. Ed. *18*, 399 (1979).

[37] *D. Seebach & T. Hassel*, Angew. Chem. *90*, 296 (1978); *ibid.* Int. Ed. *17*, 274 (1978).

[38] *A.I. Meyers, S. Hellring & W.T. Hoeve*, Tetrahedron Lett. *1981*, 5115; *A.I. Meyers & S. Hellring*, Tetrahedron Lett. *1981*, 5119.

[39] *G. Stork, R.M. Jacobson & R. Levitz*, Tetrahedron Lett. *1979*, 771.

[40] *K. Rühlmann & G. Kuhrt*, Angew. Chem. *80*, 797 (1968); *ibid.* Int. Ed. *7*, 809 (1968); *K.-D. Kaufmann, W. Thierfelder, F. Piper & K. Rühlmann*, Z. Chem. *10*, 392 (1970); *K. Rühlmann, K.-D. Kaufmann & K. Ickert*, Z. Chem. *10*, 393 (1970); *G. Stork, A.Y.W. Leong & A.M. Touzin*, J. Org. Chem. *41*, 3491 (1976); *P. Bey & J.P. Vevert*, Tetrahedron Lett. *1977*, 1455; *J.J. Fitt & H.W. Gschwend*, J. Org. Chem. *42*, 2639 (1977); *D.A. Evans & P.J. Sidebottom*, J. Chem. Soc., Chem. Commun. *1978*, 753; *P. Casara & B.M. Metcalf*, Tetrahedron Lett. *1978*, 1581; *G. Schnorrenberg & W. Steglich*, Angew. Chem. *91*, 326 (1979); *ibid.* Int. Ed. *18*, 307 (1979); *A. Shanzer, L. Somekh & D. Butina*, J. Org. Chem. *44*, 3967 (1979).

[41] *W.G. Kofron & L.M. Baclawski*, J. Org. Chem. *41*, 1879 (1976).

[42] *J. Colonge & J.M. Pouchol*, Bull. Soc. Chim. Fr. *1962*, 596.

[43] *N. Kornblum & J.W. Powers*, J. Org. Chem. *22*, 455 (1957).

[44] *N. Kornblum, H.O. Larson, R.K. Blackwood, D.D. Mooberry, E.P. Oliveto & G.E. Graham*, J. Am. Chem. Soc. *78*, 1497 (1956).

[45] *W. Kirmse & H. Arold*, Chem. Ber. *103*, 23 (1970).

[46] *D. Seebach & D. Steinmüller*, Angew. Chem. *80*, 617 (1968); *ibid.* Int. Ed. *7*, 619 (1968).

[47] *W.C. Gakenheimer & W.H. Hartung*, J. Org. Chem. *9*, 85 (1944).

[48] *D. Nightingale & J.R. Janes*, J. Am. Chem. Soc. *66*, 352 (1944).

[49] *D. Seebach & F. Lehr*, Angew. Chem. *88*, 540 (1976); *ibid.* Int. Ed. *15*, 505 (1976); *D. Seebach, R. Henning, F. Lehr & J. Gonnermann*, Tetrahedron Lett. *1977*, 1161; *D. Seebach & F. Lehr*, Helv. Chim. Acta *62*, 2239 (1979).