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AN EFFECTIVE, PRACTICAL METHOD FOR THE SYNTHESIS OF CHIRAL PROPARGYL ALCOHOLS§,*

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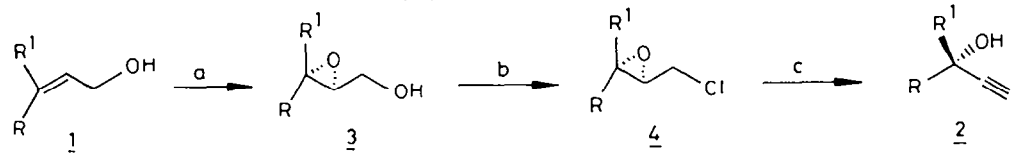
Abstract *The preparation of chiral propargyl alcohols (2) is described by $LiNH_2$ or LDA induced double elimination of chiral epoxychlorides (4), derived from their corresponding epoxyalcohols (3) which are available easily by Sharpless asymmetric epoxidation of the primary allyl alcohols. Whereas, use of stoichiometric amount of base on 4 provides chirally enriched trans-1-chlorovinyl alcohols (14).*

During our continuing studies[1] on the synthesis of hydroxy fatty acids, the utility of the terminal alkynols, as distinguished precursors, has been greatly appreciated. In addition, these intermediates find a great deal of utility in synthesis of alkaloids[2], prostaglandins[3], pyrethroids[4], leukotrienes[5], steroids[6] etc. The terminal acetylenic functionality not only leads to C-C bond formation with ease[7] but also the stereospecific coupling reaction[8] of terminal acetylene with vinyl halides under palladium catalyst, forms one of the most distinctive features of recent discoveries and has increased greatly their utility. The resultant triple bond on stereospecific reduction[9] will lead either to cis or trans alkene by a suitable choice of reagents. The chiral acetylenic alcohols are currently being made primarily either by chelation controlled acetylenic Grignard reagent[10] with aldehyde in the presence of chiral amino alcohols as ligand chelators, or enantioselective reduction of ketones with chiral hydrides[11] or by enzymatic kinetic hydrolysis[12] of corresponding esters.[13]

We have recently described novel methods for the preparation of chiral alkynols from chiral substrates such as tartaric acid[14] and carbohydrates.[15] In continuation, in this area we have developed a further novel approach for the chiral alkynols (Scheme 1). While this manuscript was under preparation, a related report appeared by Takano's group[16] which prompted us to com-

SCHEME 1



a) TIP, (+)DIPT, TBHP, mol. sieves 4A°, DCM b) Ph_3P, CCl_4, $NaHCO_3$ c) $LiNH_2$ in Liq NH_3 or LDA in THF, -30°

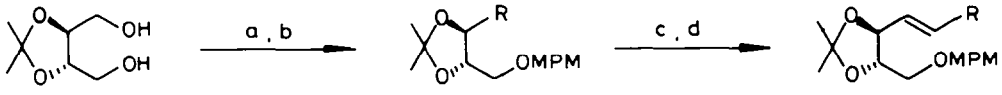
§ Part of this work was presented as an invited lecture at First NOST Conference held during December 4-8, 1988 at Hassan (India)

* This paper is dedicated to Dr Sukh Dev on the occasion of his 65th birthday.

municate our findings in detail. The salient features of our strategy are the initial conversion of allylic alcohol (**1**) into chiral 2,3-epoxyalcohol (**3**) using Sharpless epoxidation[17], transformation[18] of **3** into 2,3-epoxychloride (**4**) using Ph_3P-CCl_4 followed by treatment with $LiNH_2$ or LDA leading to the formation of chiral propargyl alcohols (**2**) in excellent yields.[19]

The substrates, allylic alcohols (**1a-1l**) with a wide variety of functionalities have been prepared by the adoption of either of the two methods, i) Wittig reaction of suitable aldehyde with (carboethoxy)methylene triphenylphosphorane followed by DIBAL-H reduction or ii) alkylation of propargyl alcohol with the required alkyl halide and subsequent LAH reduction. The allylic alcohol **1h** was prepared from (4S,5S)-4,5-(bishydroxymethyl)-2,2-dimethyl-1,3-dioxolane[20] in 4 steps as shown in Scheme 2.

SCHEME 2



5 R = CH_2OH **7** R = CO_2Et

6 R = CHO **1h** R = CH_2OH

a) MPMBr, NaH, THF b) $(COCl)_2$, DMSO, Et_3N, DCM c) $Ph_3P{=}CHCO_2Et$, Benzene d) DIBAL-H, DCM

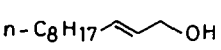
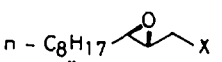
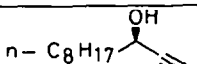
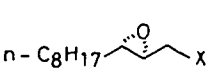
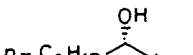
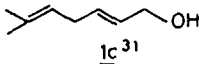
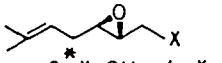
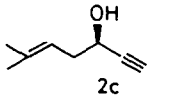
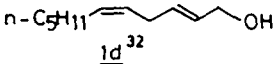
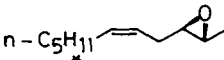
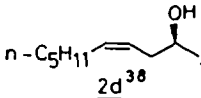
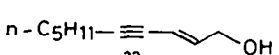
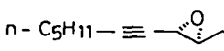
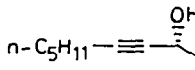
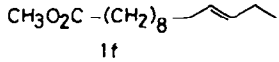
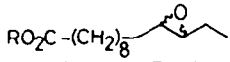
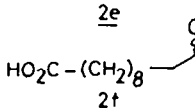
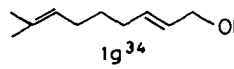
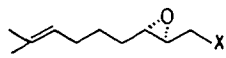
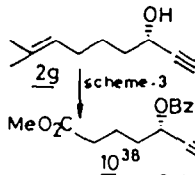
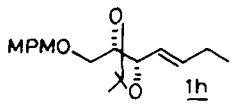
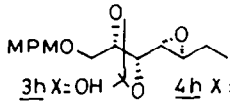
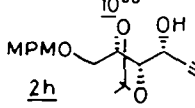
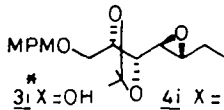
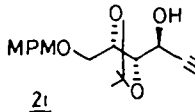
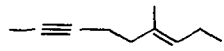
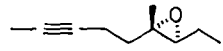
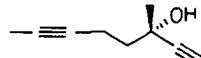
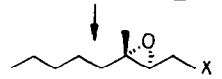
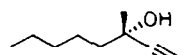
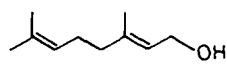
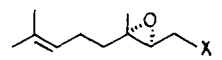
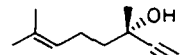
The needed chirality was introduced by Sharpless asymmetric epoxidation on allylic alcohols under standard set of conditions such as using TBHP, $Ti(OiPr)_4$ and (+) or (-) DIPT in CH_2Cl_2 in presence of 4A molecular sieves which help in the improvement of both chemical and optical yields of the required epoxides. In the case of **1f**, a racemic epoxyalcohol was prepared by using mCPBA.

The 2,3-epoxyalcohols were cleanly converted into the epoxychlorides on reaction with Ph_3P in refluxing CCl_4 in presence of trace amount of $NaHCO_3$. The final and crucial reaction is the preparation of chiral alkynols. Thus 2,3-epoxychlorides were subjected to base induced opening either by $LiNH_2$ or LDA at -30 to -33° to result in the formation of alkynols. In one case, measurement work, with Mosher's ester derivatives[21] has established that the chirality (94% ee) of the epoxide (**3b**) is transferred with its total integrity to alkynol (**2b**).

This method has been extended to a wide variety of allylic alcohols (Table 1). The entries 3 and 4 demonstrate that the skipped methylene present in the substrate has remained untouched under the reaction conditions. It is pertinent to mention that the optically active diacetylenic carbinol (**2e**) was conveniently prepared which otherwise, is relatively difficult to realise. Entry 6 deals with racemic compound because of our failure[22] to obtain optically pure epoxide from **1f**. However, the problem has been solved indirectly as indicated for entry 7, for instance **1g** was transformed into **2g** by the present methodology and then transformed to furnish ester **10** (Scheme 3) which has found application in lipoxin[23] and prostaglandin.[3]

Enantiomeric propargylic alcohols (**2h** and **2i**) shown in entries 8 and 9, prepared from R,R-tartaric acid, have opened up numerous possibilities for elaborating them into rare sugars.[24]

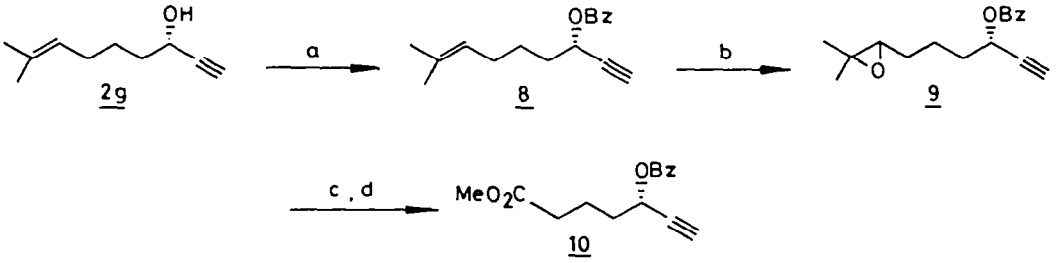
TABLE 1 Preparation of Chiral Propargyl alcohols (2)

Entries	Allylic alcohols (1)	Epoxides	Propargyl alcohols
1	 1a [30]	 3a* X=OH; 4a X = Cl	 2a [37]
2		 3b X=OH, 4b X=Cl	 2b
3	 1c [31]	 3c* X=OH; 4c X=Cl	 2c
4	 1d [32]	 3d* X=OH; 4d X=Cl	 2d [38]
5	 1e [33]	 3e X=OH; 4e X=Cl	 2e
6	 1f	 3f X=OH, R=Me 4f X=Cl, R=H	 2f
7	 1g [34]	 3g X=OH, 4g X=Cl	 2g scheme-3 10 [38]
8	 1h	 3h X=OH 4h X = Cl	 2h
9		 3i* X=OH 4i X = Cl	 2i
10	 1j [35]	 3j X=OH; 4j X = Cl	 2j
11		 3k X=OH, 4k X=Cl	 2k [26,39]
12	 1l	 3l X=OH, 4l X=Cl	 2l

* (-) DIPT was used in place of (+) DIPT

The distinct feature of this methodology is the ease of preparation of optically pure tertiary carbinols such as **2j** to **2l** (entries 10-12), which otherwise are not easily accessible.[25] The diverse usage of these carbinols in developing side chain of clinically used prostaglandins is well known.[3,26]

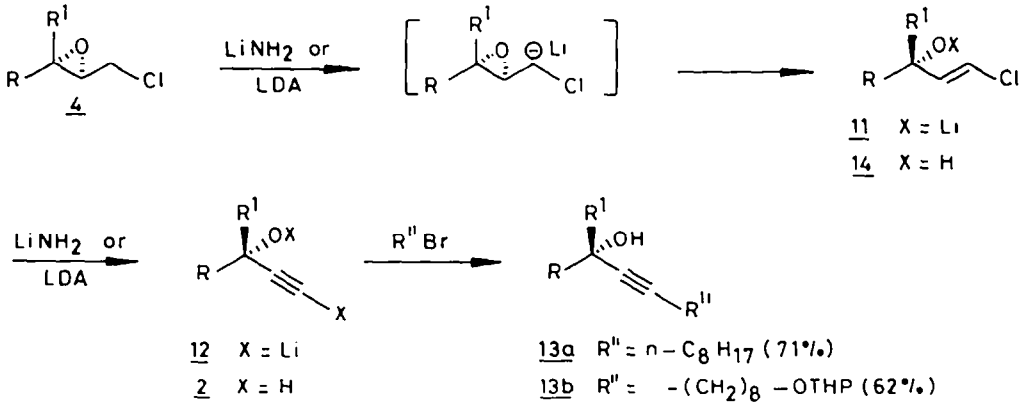
SCHEME 3



a) BzCl, Et_3N, DMAP, DCM b) MCPBA, DCM c) Jones, -20° d) CH_2N_2

A plausible mechanism for the opening of epoxychloride to form alkynol is shown in Scheme 4. Accordingly, the base abstracts[27] a proton from the chlorocarbon with concomitant cleavage of epoxide to form the vinyl chloride which then undergoes dehydrohalogenation to result the alkynol. The dianion (**12**) can be in situ alkylated chemoselectively with alkyl halides like n-octyl bromide to give C-alkylated products[28] **13a** and **13b**.

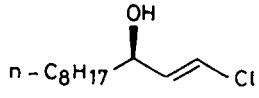
SCHEME 4



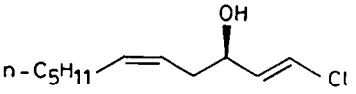
According to the mechanism shown in Scheme 4, alkoxide **11** is the crucial intermediate for the formation of propargyl alcohols from epoxychlorides **4**, in fact **14** could be isolated when the reaction was carried out with a stoichiometric quantity of base such as LDA/THF or $LiNH_2$ in liq. NH_3. These trans-1-chlorovinyl alcohols (**14**) are very useful synthons and may find wide applicability in the synthesis of biologically active compounds.[3,5]

Treatment of **4** with 1 eq. of LDA in THF at -78° or $LiNH_2$ in liq. NH_3 at -33° afforded **14** in quantitative yields. The elimination reaction produced trans-1-chlorovinyl alcohols, which

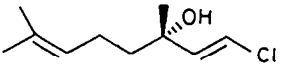
was found to be highly stereoselective and the configuration was confirmed by analysis of ^1H NMR spectra. Generality of this reaction is evident from the preparation of chlorovinyl alcohols



14a



14d



14l

14a, 14d and **14l** (Table 2) from the corresponding 2,3-epoxychlorides **4a, 4d** and **4l** respectively. This reaction appears to be general, versatile and could be performed under mild conditions.

Table 2 Preparation of trans-chlorovinyl alcohols (**14**)

Entry	Epoxy chlorides	Base	eq	Crude yield %	Chlorovinyl alcohols*	Propargyl alcohols*
1	**4a**	$LiNH_2$ or LDA	1	95	**14a** (85)	-
2	**4d**	$LiNH_2$ or LDA	1	89	**14d** (79)	-
3	**4l**	$LiNH_2$ or LDA	1	92	**14l** (82)	-
4	**4l**	$LiNH_2$ or LDA	3	81	-	**2l** (77)
5	**4l**	n-BuLi	1	94§	**14l** (41)	**2l** (19)
6	**4l**	n-BuLi	3	83	-	**2l** (77)

* Isolated yields (%) are given in parenthesis. § Also contains its unreacted epoxychloride.

We next aimed the opening of 2,3-epoxychloride **4l** with 1 eq. of n-BuLi in THF at -33°. It resulted a product mixture containing approximately 43, 20 and 36 per cent of chlorovinyl alcohol (**14l**), propargyl alcohol (**2l**) and the starting 2,3-epoxychloride (**4l**) respectively. It appears that n-BuLi reacts indiscriminately with both the epoxychloride (**4l**) and chlorovinyl alcohol (**14l**), formed during the course of the reaction, thereby giving a mixture of products. However, 3 eq. of n-BuLi in THF at -33° always produced the propargyl alcohol (**2l**) as the sole product reported earlier.[16,40] Thus, LDA or $LiNH_2$ is the suitable base for the preparation of compound **14**.

In conclusion, it is pertinent to mention that this is a highly useful method to prepare chirally enriched intermediates alkynols, especially the tertiary carbinols and trans-1-chlorovinyl alcohols from easily accessible 2,3-epoxychlorides obtainable from the corresponding allylic alcohols, using 3 eq. of bases and 1 eq. of LDA/$LiNH_2$ respectively. The ease with which these transformations can be carried out under mild conditions tolerated by many functional groups in high chemical and optical yields will allow one to tap the immense potential which these intermediates[29] possess.

EXPERIMENTAL

IR spectra were recorded as neat thin film on Perkin-Elmer 683 or 1310 spectrometers. ^1H NMR spectra were recorded on Varian FT 80A or Jeol PMX-90 spectrometers, in $CDCl_3$ using TMS as internal standard. Mass spectra were recorded on either Micromass 7070H or Finni-

gan Mat 1020 B mass spectrometer operating at 70 eV and molecular weights determined by CI technique. Allyl alcohols were prepared by the literature procedures.

(4S,5S)-4-(3-Hydroxy-1E-propenyl)-5-(p-methoxybenzyloxymethyl)-2,2-dimethyl-1,3-dioxolane (1h). A cooled (0°) and stirred suspension of sodium hydride (2.96 g, 61.7 mmol, 50% suspension) in dry THF (100 ml) and HMPA (5 ml) was treated with (4S,5S)-4,5-(bis-hydroxymethyl)-2,2-dimethyl-1,3-dioxolane (10 g, 61.7 mmol) during 20 min. After 1 h p-methoxybenzyl bromide (MPMBr) (12.4 g, 61.7 mmol) in dry THF (10 ml) was added dropwise and allowed to stir overnight at room temperature. Reaction mixture was cooled (0°), quenched with aq. NH_4Cl and extracted with $CHCl_3$. Organic layer was washed with water, dried (Na_2SO_4) and evaporated. The residue was purified by column chromatography (silica gel, 10% ethyl acetate-pet.ether) to afford **5** (13.2 g) in 76% yield. ^1H NMR : δ 1.43 (s, 6H), 3.64-4.12 (m, 9H), 3.8 (s, 3H), 4.5 (s, 2H), 6.81 (d, 2H), 7.18 (d, 2H), M^+ 266.

To a cooled (-78°) and stirred solution of oxalylchloride (5 ml, 57.3 mmol) in CH_2Cl_2) (140 ml) was added dropwise DMSO (9 ml, 12.6 mmol). After 5 min. alcohol **5** (5 g, 17.7 mmol) was added, left for 20 min and quenched with triethylamine (10 ml, 143 mmol). After 10 min reaction mixture was poured in water, organic layer separated and the aqueous layer extracted with CH_2Cl_2. Combined CH_2Cl_2 extracts were washed with 1% HCl, water, brine, dried (Na_2SO_4) and evaporated to give the crude aldehyde **6**, which was used as such for further reaction.

A stirred suspension of (carboethoxymethylene) triphenylphosphorane (7.4 g, 21.4 mmol) in benzene (50 ml) was treated with **6** (5 g, 17.8 mmol) at room temperature. After 1 h, benzene was removed under reduced pressure and residue was subjected to chromatographic purification (Si-gel, 5% ethyl acetate-pet.ether) to afford **7** (5 g) in 80% yield as a liquid. ^1H NMR : δ 1.25 (t, 3H), 1.4 (s, 6H), 3.5 (dist. t, 2H), 3.75 (s, 3H), 4.0-4.4 (m, 4H), 4.5 (s, 2H), 5.3 (t, 1H), 5.6 (d, 1H), 6.08 (d, 2H), 7.25 (d, 2H).

To a stirred and cooled (-20°) solution of **7** (5 g, 14.28 mmol) in CH_2Cl_2 (50 ml), a 20% hexane solution of DIBAL-H (22 ml, 30 mmol) was added during 20 min. After 1 h, it was quenched with aq. sodium potassium tartarate solution. Aq. layer was separated and extracted with CH_2Cl_2. Organic layer was washed with water, brine, dried (Na_2SO_4) and evaporated under reduced pressure to result the alcohol **1h** (4 g) in 90% yield as a liquid. ^1H NMR : δ 1.4 (s, 6H), 3.5 (dist. t, 3H), 3.8 (s, 3H), 6.85 (d, 2H), 7.3 (d, 2H).

General procedure for the preparation of 2,3-epoxy alcohols

(2R-trans)-3-Octyloxiranemethanol (3a). To a stirred and cooled (-20°) suspension of activated, powdered 4Å molecular sieves (5 g) in CH_2Cl_2 (250 ml) under N_2 atmosphere (-) DIPT (0.412 g, 1.76 mmol), $Ti(OiPr)_4$ (0.417 g, 1.47 mmol) and TBHP (3.97 g, 44.11 mmol) were added sequentially. The resulting mixture after 20 min was treated with allylic alcohol **1a** (5 g, 29.41 mmol) in CH_2Cl_2 (10 ml) over a period of 20 min and maintained at this temperature for 4 h. The reaction mixture was allowed to warm to 0° and poured into a freshly prepared and cooled (0°) solution of ferrous sulfate and tartaric acid (6.5 g and 2 g respectively) in deionised water (20 ml). The two phase mixture was stirred for 25-30 min, aq. phase separated and extracted with ether. The combined organic phases were treated with a precooled (0°) solution of 30% NaOH (W/V) in saturated brine. The two phase mixture was then stirred for 1 h at room temperature

and aq. layer separated. It was treated with ether, combined organic extracts were dried (Na_2SO_4) and concentrated under reduced pressure to result **3a** (5.1 g) in 91% yield as a solid, m.p. 58-59°C. ^1H NMR : δ 0.91 (t, 3H), 1.20-1.75 (m, 14H), 1.8-1.9 (m, 1H), 2.9-3.0 (m, 2H), 3.65 (dd, 1H), 3.95 (dd, 1H). IR : 3600 and 1250 cm^{-1}. M^+ 186. $[\alpha]_D$ +34.3 (c 1.2, $CHCl_3$).

(2S-trans)-3-Octyloxiranemethanol (3b). Compound **3b** was prepared from allylic alcohol (**1a**) (5 g, 29.41 mmol) by using (+) DIPT in 88% yield. ^1H NMR : δ 0.90 (t, 3H), 1.1-1.8 (m, 14H), 1.81-1.90 (m, 1H), 2.95-3.00 (m, 2H), 3.68 (dd, 1H), 3.90 (dd, 1H). $[\alpha]_D$ = -34.6° (c, 1.2, $CHCl_3$).

(2R-trans)-3-(3-Methyl-2-butenyl)oxiranemethanol (3c). Compound **3c** was prepared from allylic alcohol **1c** (4.3 g, 34.12 mmol) using (-) DIPT in 90% yield. ^1H NMR : δ 1.65 (s, 3H), 1.75 (s, 3H), 2.25 (bt, 2H), 2.75-3.20 (m, 2H), 4.4 (d, 2H), 5.1 (bt, 1H). IR : 3400, 1450 and 1220 cm^{-1}. M^+ 142. $[\alpha]_D$ +16.27 (c, 1.9, $CHCl_3$). Anal. Calcd. for $C_8H_{14}O_2$: C, 67.57; H, 9.92; Found : C, 67.60; H, 9.96%.

(2R-trans)-3-(2-Heptenyl)oxiranemethanol (3d). Compound **3d** was prepared from alcohol **1d** (5 g, 29.79 mmol) in 82% yield, using (-) DIPT. ^1H NMR : δ 0.85 (t, 3H), 1.1-1.5 (m, 6H), 1.8-2.4 (m, 4H), 2.8-3.1 (m, 2H), 5.1-5.7 (m, 2H). IR : 3400 and 1250 cm^{-1}. M^+ 184. $[\alpha]_D$ +14.18 (c 1.65, $CHCl_3$). Anal. Calcd. for $C_{11}H_{20}O_2$. C, 71.69; H, 10.94; Found : C, 71.61; H, 10.98%.

(2S-trans)-3-(1-Heptynyl)oxiranemethanol (3e). Epoxidation of **1e** (3.7 g, 24.34 mmol) gave **3e** in 88% yield using (+) DIPT. ^1H NMR : δ 0.75 (t, 3H), 1.1-1.6 (m, 10H), 2.2-2.4 (m, 2H), 3.75-4.00 (m, 2H), 4.0-4.2 (m, 2H). IR : 3400, 2230 and 1260 cm^{-1}. M^+ 168. $[\alpha]_D$ -4.07 (c 2.75, $CHCl_3$). Anal. Calcd. for $C_{10}H_{16}O_2$: C, 71.39; H, 9.59; Found : C, 71.38; H, 9.57%.

(2RS-trans)-3-(10-Methoxycarbonyldecyl)oxiranemethanol (3f). A solution of alcohol **1f** (2 g, 8.77 mmol) in CH_2Cl_2 (30 ml) was treated with mCPBA (1.81 g, 10.52 mmol) under N_2 atmosphere at 0° for 30 min. Usual workup gave **3f** (1.51 g) in 70% yield in racemic form. ^1H NMR : δ 1.20-1.65 (m, 16H), 2.27 (dist. t, 2H), 2.8-3.0 (m, 2H), 3.5 (dd, 2H), 3.7 (s, 3H). IR : 3450, 1720 and 1260 cm^{-1}.

(2S-trans)-3-(5-Methyl-4-hexenyl)oxiranemethanol (3g). Compound **3g** was prepared from **1g** (7.2 g, 46.75 mmol) in 86% yield by using (+) DIPT. ^1H NMR : δ 1.2-2.1 (m, 10H), 2.2-2.5 (m, 2H), 2.7-3.0 (m, 2H), 3.6 (d, 2H), 5.0 (dist. t, 1H). IR : 3400, 1450 and 1220 cm^{-1}. M^+ 170. $[\alpha]_D$ = -32.2 (c 2, $CHCl_3$). Anal. Calcd. for $C_{10}H_{18}O_2$: C, 70.54; H, 10.66; Found : C, 70.51; H, 10.40%.

(2S-trans)-3-(3-p-Methoxybenzyloxymethyl-1S,2S-O-isopropylidinepropyl)oxiranemethanol (3h). Alcohol **1h** (5.2 g, 16.88 mmol) on epoxidation with (+) DIPT gave epoxide **3h** in 84% yield. ^1H NMR : δ 1.25 (s, 6H), 2.85-3.10 (m, 2H), 3.4-3.7 (m, 4H), 3.7 (br s, 4H), 4.0-4.2 (m, 1H), 4.45 (s, 2H), 6.8 (d, 2H), 7.2 (d, 2H). IR : 3460, 1510 and 1460 cm^{-1}. M^+ 324. $[\alpha]_D$ -12.2° (c 1, $CHCl_3$). Anal. Calcd. for $C_{17}H_{24}O_6$: C, 62.95; H, 7.46; Found : C, 62.92; H, 7.46%.

(2R-trans)-3-(3-p-Methoxybenzyloxymethyl-1S,2S-O-isopropylidinepropyl)oxiranemethanol (3i). Alcohol **1h** (5.2 g, 16.88 mmol) on epoxidation with (-) DIPT gave epoxide **3i** in 86% yield. ^1H NMR : δ 1.20 (s, 6H), 2.8-3.0 (m, 2H), 3.36-3.70 (m, 4H), 3.72 (br s, 4H), 4.00-4.23 (m, 1H), 4.4 (s, 2H), 6.8 (d, 2H), 7.2 (d, 2H). $[\alpha]_D$ -17.15° (c 1.3, $CHCl_3$).

(2S-trans)-3-Mehyl-3-(3-pentynyl)oxiranemethanol (3j). Epoxy alcohol **3j** was prepared from **1j** (5 g, 36.23 mmol) in 84% yield. ^1H NMR : δ 1.25 (t, 3H), 1.6-1.9 (m, 5H), 2.1-2.4 (m, 2H), 3.05 (t, 1H), 3.8 (br d, 2H). IR : 3500, 2200 and 1250 cm^{-1}. M^+ 154. $[\alpha]_D$ = -9.8° (c 1.2, $CHCl_3$). Anal.

Calcd. for $C_9H_{14}O_2$: C, 70.10; H, 9.15; Found : C, 70.14; H, 9.10%.

(2S-trans)-3-Methyl-(3-pentyl)oxiranemethanol (3k). Epoxy alcohol **3k** was prepared from **3j** (1.2 g, 7.79 mmol) by catalytic hydrogenation with 10% Pd-C in ethanol under atmospheric pressure at room temperature in 90% yield. ^{1}H NMR : δ 0.9 (t, 3H), 1.09-1.50 (m, 11H), 2.95 (t, 1H), 3.72 (d, 2H). IR : 3400 and 1250 cm^{-1}. M$^+$ 158. $[\alpha]_D$ = -6.2° (c 1.48, $CHCl_3$). Anal. Calcd. for $C_9H_{18}O_2$: C, 68.31; H, 11.47; Found : C, 68.28; H, 11.47%.

(2S-trans)-3-Methyl-3-(4-methyl-3-pentenyl)oxaranemethanol (3l). Compound **3l** was prepared from geraniol (3 g, 19.48 mmol) in 86% yield. ^{1}H NMR : δ 1.04 (s, 3H), 1.3-1.7 (m, 3H), 1.46 (s, 3H), 1.63 (s, 3H), 2.02 (q, 2H), 2.8 (dd, 1H), 3.3-3.6 (m, 2H), 5.1 (br t, 1H). IR : 3400, 1450 and 1250 cm^{-1}. M$^+$ 170. $[\alpha]_D$ = -5.2° (c 1.44, $CHCl_3$).

General procedure for the preparation of 2,3-epoxychlorides

(2S-trans)-3-Octyloxiranemethylchloride (4a). A stirred mixture of epoxy alcohol **3a** (2 g, 10.75 mmol), Ph_3P (2.81 g, 10.75 mmol) and $NaHCO_3$ (0.2 g) in CCl_4 (30 ml) under N_2 atmosphere was heated at reflux for 3 h. CCl_4 was removed on a rotary evaporator and residue was purified by column chromatography (Si-gel, pet. ether) to furnish the epoxy chloride **4a** (1.9 g) in 90% yield. ^{1}H NMR : δ 0.7 (t, 3H), 1.0-1.6 (m, 14H), 2.6-3.0 (m, 2H), 3.4 (dd, 2H). IR : 1460 and 1260 cm^{-1}. M$^+$ 204, 206. $[\alpha]_D$ = +18.8° (c 2.5, $CHCl_3$). Anal. Calcd. for $C_{11}H_{21}ClO$: C, 64.53; H, 10.34; Found : C, 64.67; H, 10.25%.

(2R-trans)-3-Octyloxiranemethylchloride (4b). Compound **4b** was prepared from **3b** (4.2 g, 22.5 mmol) in 85% yield. ^{1}H NMR : δ 0.72 (t, 3H), 0.9-1.6 (m, 14H), 2.7-3.1 (m, 2H), 3.4 (dd, 2H). $[\alpha]_D$ = -19.76° (c 0.85, $CHCl_3$).

(2S-trans)-3-(3-Methyl-2-butenyl)oxiranemethylchloride (4c). Compound **4c** was prepared from **3c** (3.8 g, 26.76 mmol) in 86% yield. ^{1}H NMR : δ 1.65 (s, 3H), 1.75 (s, 3H), 2.25 (t, 2H), 2.75-3.10 (m, 2H), 3.55 (d, 2H). IR : 1440 and 1260 cm^{-1}. M$^+$ 160, 162. $[\alpha]_D$ = +7.37° (c 2.3, $CHCl_3$). Anal. Calcd. for $C_8H_{13}ClO$: C, 59.81; H, 8.16; Found : C, 59.90; H, 8.17%.

(2S-trans)-3-(2-Heptenyl)oxiranemethylchloride (4d). Epoxychloride **4d** was prepared from alcohol **3d** (4.7 g, 25.54 mmol) in 91% yield. ^{1}H NMR : δ 0.9 (t, 3H), 1.2-1.7 (m, 6H), 2.00-2.25 (m, 2H), 2.95-3.30 (m, 2H), 3.50-3.65 (m, 2H), 3.55-3.85 (dt, 2H). IR : 1460 and 1250 cm^{-1}. M$^+$ 202, 204. $[\alpha]_D$ = -1.81° (c 1.1, $CHCl_3$). Anal. Calcd. for $C_{11}H_{19}ClO$: C, 65.17; H, 9.44; Found : C, 65.31; H, 9.38%.

(2R-trans)-3-(1-Heptynyl)oxiranemethylchloride (4e). Compound **4e** was prepared from **3e** (3.1 g, 18.45 mmol) in 82% yield. ^{1}H NMR : δ 0.72 (t, 3H), 1.0-1.7 (m, 6H), 2.09 (dist t, 2H), 3.18 (dd, 2H), 3.5 (d, 2H). IR : 1460 and 1250 cm^{-1}. M$^+$ 186, 188. $[\alpha]_D$ -2.9° (c 1.12, $CHCl_3$). Anal. Calcd. for $C_{10}H_{15}ClO$: C, 64.33; H, 8.09; Found : C, 64.54; H, 8.0%.

(2SR-trans)-3-(10-Methoxycarbonyldecyl)oxiranemethylchloride (4f). A mixture of epoxy ester **3f** (1 g, 4.09 mmol), Ph_3P (1.0 g, 4.09 mmol) and $NaHCO_3$ (0.1 g) in CCl_4 was heated at reflux for 4 h. The reaction mixture after usual workup gave the epoxy chloride. The above epoxy chloride (0.89 g) was subjected to hydrolysis with KOH (0.190 g) in 1:1 aq. methanol (3.3 ml) at room temperature for 12 h. Usual workup gave **4f** in 85% yield. ^{1}H NMR : δ 1.1-1.8 (m, 16H), 2.22 (dist t, 2H), 2.7-3.0 (m, 2H), 3.51 (dd, 2H). IR : 1730, 1450 and 1260 cm^{-1}.

(2R-trans)-3-(5-Methyl-4-hexenyl)oxiranemethylchloride (4g). Compound **4g** was prepared from **3g** (5.7 g, 33.52 mmol) in 86% yield. ^{1}H NMR : δ 1.4 (t, 3H), 1.5 (t, 3H), 1.25-1.60 (m, 4H), 1.8-2.1 (m, 2H), 2.6-3.0 (m, 2H), 3.5 (dd, 2H), 5.05 (dist t, 1H). IR : 1440 and 1260 cm^{-1}. M$^+$ 188, 190. $[\alpha]_D$ = -16° (c 1.77, $CHCl_3$). Anal. Calcd. for $C_{10}H_{17}ClO$: C, 63.65; H, 9.08; Found : C, 63.81; H, 9.3%.

(2R-trans)-3-(3-p-Methoxybenzyloxymethyl-1S,2S-O-isopropyledinepropyl)oxiranemethylchloride (4h). **4h** was prepared from **3h** (3.8 g, 11.72 mmol) in 87% yield. ^{1}H NMR : δ 1.2 (s, 6H), 2.9 (dd, 1H), 3.1 (dd, 1H), 3.4-3.6 (m, 4H), 3.7 (br s, 4H), 3.9-4.1 (m, 1H), 4.4 (s, 2H), 6.8 (d, 2H), 7.2 (d, 2H). IR : 1460 and 1250 cm^{-1}. M$^+$ 342, 344. $[\alpha]_D$ = +8.14° (c 1.4, $CHCl_3$). Anal. Calcd. for $C_{17}H_{23}ClO_5$: C, 59.56; H, 6.76; Found : C, 59.60; H, 6.78%.

(2S-trans)-3-(3-p-Methoxybenzyloxymethyl-1S,2S-O-isopropyledinepropyl)oxiranemethylchloride (4i). **4i** was prepared from **3i** (3 g, 9.25 mmol) in 90% yield. ^{1}H NMR : δ 1.1 (s, 6H), 2.93 (dd, 1H), 3.0 (dd, 1H), 3.4-3.7 (m, 4H), 3.7 (br s, 4H), 3.8-4.1 (m, 1H), 4.4 (s, 2H), 6.75 (d, 2H), 7.2 (d, 2H). $[\alpha]_D$ = -11.19° (c 1.09, $CHCl_3$).

(2R-trans)-3-Methyl-3-(3-pentynyl)oxiranemethylchloride (4j). Compound **4j** was prepared from **3j** (4.3 g, 27.92 mmol) in 90% yield. ^{1}H NMR : δ 1.2 (s, 3H), 1.3-1.7 (m, 5H), 2.0-2.3 (m, 2H), 3.05 (t, 1H), 3.3-3.7 (m, 2H). IR : 2100, 1450 and 1250 cm^{-1}. M$^+$ 172, 174. $[\alpha]_D$ = -3.43° (c 1.92, $CHCl_3$). Anal. Calcd. for $C_9H_{13}ClO$: C, 62.61; H, 7.59; Found : C, 62.76; H, 7.59%.

(2R-trans)-3-Methyl-3-pentyloxiranemethylchloride (4k). Compound **4k** was prepared from **3k** (0.945 g, 5.98 mmol) in 82% yield. ^{1}H NMR : δ 0.9 (t, 3H), 1.1-1.6 (m, 11H), 2.9 (t, 1H), 3.4-3.7 (m, 2H). IR : 1450 and 1250 cm^{-1}. M$^+$ 176, 178. $[\alpha]_D$ = -3.5° (c 0.2, $CHCl_3$). Anal. Calcd. for $C_9H_{17}ClO$: C, 61.18; H, 9.70; Found : C, 61.25; H, 9.60%.

(2R-trans)-3-Methyl-3-(4-methyl-3-pentenyl)oxiranemethylchloride (4l). Epoxychloride **4l** was prepared from **3l** (2.6 g, 15.29 mmol) in 85% yield. ^{1}H NMR : δ 1.0-1.3 (m, 5H), 1.4-1.7 (m, 8H), 2.8-3.1 (m, 1H), 3.2-3.8 (m, 2H), 4.8-5.1 (t, 1H). IR : 1460 and 1260 cm^{-1}. M$^+$ 188, 190. $[\alpha]_D$ = +10.19° (c 1.02, $CHCl_3$). Anal. Calcd. for $C_{10}H_{17}ClO$: C, 63.64; H, 9.08; Found: C, 63.81; H, 9.10%.

General procedure for the preparation of chiral carbinols

(3R)-1-Undecyn-3-ol (2a). Method A : To a freshly prepared $LiNH_2$ [prepared from lithium (0.154 g, 0.022 g atom)] in liq. NH_3 (15 ml) at -33°, epoxy chloride **4a** (1.5 g, 7.35 mmol) in THF (3 ml) was added and allowed to stir for 1 h. Ammonia was allowed to evaporate, after quenching it by solid NH_4Cl. Residue was treated with water (in the case of **2f**, with 10% HCl), extracted with ether. Ethereal layer was washed with water, dried (Na_2SO_4) and evaporated. Purification of the residue by column chromatography (Si-gel, 2% ethyl acetate - pet. ether) gave, chiral carbinol **2a**[36] (0.99 g) in 76% yield. ^{1}H NMR : δ 0.71 (t, 3H), 1.0-1.8 (m, 14H), 2.3 (d, 1H), 4.2 (dt, 1H). IR : 3450 and 3320 cm^{-1}. M$^+$ 168. $[\alpha]_D$ = +15.1° (c 2.3, $CHCl_3$).

Method B : To a freshly prepared LDA [prepared from diisopropylamine (1.48 g, 14.70 mmol)] and n-BuLi (0.941 g, 14.70 mmol, n-hexane solution)] in THF (15 ml), epoxy chloride (1 g, 4.9 mmol) in THF (2 ml) was added at -30°. After 1 h, it was quenched with aq. NH_4Cl and diluted with CH_2Cl_2. Organic layer was washed with water, brine and dried (Na_2SO_4); evaporated and

purified by column chromatography (Si-gel, 2% ethylacetate - pet. ether) to give **2a** (0.54 g) in 62% yield, comparable with the material prepared by Method A.

(3S)-1-Undecyn-3-ol (2b). Compound **2b**[36] was prepared from **4b** (1.2 g, 5.88 mmol) in 80% yield. ^{1}H NMR : δ 0.75 (t, 3H), 1.0-1.7 (m, 14H), 2.25 (d, 1H), 4.23 (dt, 1H). $[\alpha]_D$ = -15.2° (c 1.1, $CHCl_3$).

(3R)-6-Methylhept-5-en-1-yn-3-ol (2c). Compound **2c** was prepared from **4c** (1 g, 6.25 mmol) in 72% yield. ^{1}H NMR : δ 1.4 (s, 3H), 1.5 (s, 3H), 2.10-2.41 (m, 2H), 2.25 (d, 1H), 4.0-4.3 (dt, 1H), 4.9-5.2 (t, 1H). IR : 3450, 3320 and 2120 cm^{-1}. M^+ 124. $[\alpha]_D$ = +8.5° (c 0.7, $CHCl_3$). Anal. Calcd. for $C_8H_{12}O$: C, 77.37; H, 9.74; Found : C, 77.38; H, 9.74%.

(3R)-Undec-5-en-1-yn-3-ol (2d). Carbinol **2d** was prepared from **4d** (1.8 g, 8.91 mmol) in 76% yield. ^{1}H NMR : δ 0.9 (t, 3H), 1.2-1.6 (m, 6H), 1.95-2.30 (t, 2H), 2.50-2.75 (m, 2H), 4.30-4.65 (t, 1H), 5.45-5.95 (m, 2H). IR : 3400, 3300 and 2120 cm^{-1}. M^+ 166. $[\alpha]_D$ = +17.28° (c 1.25, $CHCl_3$). Anal. Calcd. for $C_{11}H_{18}O$: C, 79.46; H, 10.92; Found : C, 79.44; H, 10.95%.

(3R)-Decadi-1,4-yn-3-ol (2e). Carbinol **2e** was prepared from **4e** (1.3 g, 6.98 mmol) in 72% yield. ^{1}H NMR : δ 0.8 (t, 3H), 1.2-2.0 (m, 6H), 2.2 (t, 2H), 2.5 (d, 1H), 5.1 (s, 1H). IR : 3400 and 3320 cm^{-1}. M^+ 150. $[\alpha]_D$ = -1.33° (c 1.5, $CHCl_3$). Anal. Calcd. for $C_{10}H_{14}O$: C, 79.95; H, 9.39; Found : C, 79.91; H, 9.41%.

11-Hydroxy-12-tridecynoic acid (2f). Compound **4f** (0.725 g, 2.76 mmol) gave **2f** in 76% yield. ^{1}H NMR : δ 1.0-1.8 (m, 16H), 2.10-2.45 (m, 3H), 4.25-4.45 (dt, 1H), 5.5 (2H, D_2O exchangable). IR : 3500, 3320, 2120 and 1720 cm^{-1}.

(3S)-8-Methylnon-7-en-1-yn-3-ol (2g). Compound **2g** was prepared from **4g** (2.1 g, 11.17 mmol) in 74% yield. ^{1}H NMR : δ 1.5 (t, 3H), 1.6 (t, 3H), 1.4-1.7 (m, 6H), 1.9 (dist. t, 2H), 2.4 (d, 1H), 4.1-4.4 (m, 1H), 5.05 (t, 1H). IR : 3400, 3300, 2100, 1450 cm^{-1}. M^+ 152. $[\alpha]_D$ = -5.11° (c 0.9, $CHCl_3$). Anal. Calcd. for $C_{10}H_{16}O$: C, 78.89; H, 10.59; Found : C, 78.90; H, 10.69%.

(4S,5S)-4-[(1R)-1-Hydroxy-2-propynyl)]-5-p-methoxybenzyloxymethyl-2,2-dimethyl-1,3-dioxolane (2h). Opening of **4h** (2.1 g, 6.14 mmol) afforded the carbinol **2h** in 79% yield. ^{1}H NMR : δ 1.4 (s, 6H), 2.4 (d, 1H), 3.50-3.65 (m, 3H), 3.7 (s, 3H), 3.8 (dist. t, 1H), 4.2 (t, 1H), 4.5 (s, 2H), 6.8 (d, 2H), 7.2 (d, 2H). IR : 3440, 3210, 1610, 1460 and 1240 cm^{-1}. M^+ 306. $[\alpha]_D$ -7.55° (c 0.9, $CHCl_3$). Anal. Calcd. for $C_{17}H_{22}O_5$: C, 66.21; H, 7.85; Found : C, 66.19; H, 7.81%.

(4S,5S)-4-[(1S)-1-Hydroxy-2-propynyl)]-5-p-methoxybenzyloxymethyl-2,2-dimethyl-1,3-dioxolane (2i). Opening of **4i** (1.8 g, 5.26 mmol) afforded the carbinol **2i** in 80% yield. ^{1}H NMR : δ 1.38 (s, 6H), 2.38 (d, 1H), 3.48-3.60 (m, 3H), 3.68 (s, 3H), 3.8 (dist. t, 1H), 4.1 (t, 1H), 4.5 (s, 2H), 6.8 (d, 2H), 7.2 (d, 2H), $[\alpha]_D$ = -4.44° (c 0.85, $CHCl_3$).

(3S)-3-Methyl-1,6-octadiyn-3-ol (2j). Compound **2j** was prepared from **4j** (2.2 g, 12.79 mmol) in 79% yield. ^{1}H NMR : δ 1.5 (s, 3H), 1.70-1.95 (m, 5H), 2.3-2.5 (m, 2H), 2.55 (s, 1H). IR : 3450, 3300 and 2120 cm^{-1}. M^+ 136. $[\alpha]_D$ - -4.71° (c 0.7, $CHCl_3$). Anal. Calcd. for $C_9H_{12}O$: C, 79.37; H, 8.88; Found : C, 79.34; H, 8.90%.

(3S)-3-Methyl-1-octyn-3-ol (2k). Compound **2k** was prepared from **4k** (0.510 g, 2.89 mmol) in 74% yield. ^{1}H NMR : δ 0.92 (t, 3H), 1.20-1.35 (m, 6H), 1.45-1.65 (m, 6H), 2.4 (s, 1H). IR : 3450, 3300 and 2120 cm^{-1}. M^+ 140. $[\alpha]_D$ = -3.5° (c 0.2, $CHCl_3$). Anal. Calcd. for $C_9H_{16}O$: C, 77.09, H, 11.50; Found : C, 77.12; H, 11.54%.

(3S)-3,7-Dimethyloct-7-en-1-yn-3-ol (2l). Compound **2l** was prepared from **4l** (1.3 g, 6.91 mmol) in 77% yield. ^{1}H NMR : δ 1.25 (s, 3H), 1.35-1.45 (m, 8H), 1.8-2.1 (m, 2H), 2.25 (s, 1H), 4.8-5.1 (s, 1H). IR : 3400 and 3300 cm^{-1}. M$^+$ 152. $[\alpha]_D$ = -12.97° (c 1.77, $CHCl_3$). Anal. Calcd. for $C_{10}H_{16}O$: C, 78.89; H, 10.59; Found : C, 78.87; H, 10.62%.

Methyl 5-(R)-benzoyloxyhept-6-ynoate (10). A solution of triethylamine (1.6 ml, 12 mmol) and alcohol **2g** (0.6 g, 4 mmol) in CH_2Cl_2 (15 ml) containing catalytic amount of DMAP was treated with benzoyl chloride (0.7 ml, 6 mmol) at 0°. After 30 min it was diluted with water, extracted with $CHCl_3$. Organic layer was washed with water, brine and dried (Na_2SO_4). Evaporation of solvent gave the benzoate **8** (0.80 g) in 80% yield as a liquid. ^{1}H NMR : δ 1.6 (s, 3H), 1.7 (s, 3H), 1.65-2.10 (m, 6H), 2.5 (d, 1H), 5.1 (dist t, 1H), 5.6 (t, 1H), 7.3-7.6 (m, 3H), 8.05 (dd, 2H). $[\alpha]_D$ = -20.2° (c 1.04, $CHCl_3$). A solution of compound **8** (0.7 g, 2.73 mmol) in CH_2Cl_2 (15 ml) was treated with mCPBA (0.447 g, 3.5 mmol) at 0° for 1 h, it was quenched with aq. sodium metabisulphate and aq. layer was separated. Organic layer was washed with aq. $NaHCO_3$, water, dried (Na_2CO_3) and evaporated to give the epoxide **9** (0.5 g) in 67% yield, which was used as such for further reaction. ^{1}H NMR : δ 1.2 (d, 3H), 1.5 (s, 3H), 1.7-2.0 (m, 6H), 2.45 (d, 1H), 2.75 (t, 1H), 5.6 (dist t, 1H), 7.2-7.6 (m, 3H), 7.90-8.15 (dd, 2H).

Epoxide **9** (0.4 g, 1.47 mmol) in acetone (10 ml) at -20°, was subjected to oxidation with Jones' reagent (4 ml) for 1 h, it was quenched with isopropanol filtered and filterate was evaporated. Residue was taken in water, washed with ether and neutralised with dil. HCl, extracted with ethyl acetate. Organic layer was dried (Na_2SO_4) and evaporated. The residue, thus obtained, was treated with ethereal diazomethane at 0°C, to give ester **10** (0.229 g) in 60% yield as a liquid. ^{1}H NMR : δ 1.85-2.05 (m, 4H), 2.4 (t, 2H), 2.5 (d, 1H), 3.7 (s, 3H), 5.7 (dist t, 1H), 7.4-7.6 (m, 3H), 7.9-8.1 (dd, 2H). $[\alpha]_D$ -26.2° (c 1.70, $CHCl_3$).

(9S)-10-Nonadecyn-9-ol (13a). To a freshly prepared $LiNH_2$ [prepared from Li (0.154 g, 0.022 g atom)] in liq. NH_3 (15 ml) epoxy chloride **4b** (1.5 g, 7.35 mmol) in dry THF (1 ml) was added and allowed to stir for 1 h, n-octyl bromide (1.4 g, 7.35 mmol) in THF (2 ml) was added dropwise. After 3 h it was quenched with solid NH_4Cl and ammonia was allowed to evaporate. Reaction mixture was diluted with water and extracted with ether. Organic layer was washed with water, brine, dried (Na_2SO_4) and evaporated. Residue upon chromatographic purification (Si-gel, 2%, ethyl acetate : pet. ether) gave **13a** (1.45 g) in 71% yield as liquid. ^{1}H NMR : δ 0.87 (dist t, 6H), 1.00-1.65 (m, 26H), 2.1 (t, 2H), 4.25 (br s, 1H). IR : 3500 cm^{-1}, M$^+$ 280. $[\alpha]_D$ -1.95 (c 1.74, $CHCl_3$).

(11S)-1-Tetrahydropyranyloxy-9-nonadecyn-11-ol (13b). Compound **13b** was prepared from **4b** by alkylating with 1-tetrahydropyranyl ether of 8-bromo-octanol in 62% yield. ^{1}H NMR : δ 0.87 (dist t, 3H), 1.09-1.80 (m, 32H), 2.15 (t, 2H), 3.2-3.8 (m, 4H), 4.28 (br t, 1H), 4.5 (br s, 1H). IR : 3450 and 1250 cm^{-1}.

General procedure for the preparation of trans-1-chlorovinyl alcohols

(1E,3R)-1-Chloro-1-undecen-3-ol (14a). Method A : To a freshly prepared suspension of $LiNH_2$ in liq. NH_3 [prepared from 0.021 g atom lithium in liq. NH_3 (5 ml)] was added epoxy chloride **4a** (0.612 g, 3 mmol) in THF (1 ml) at -33°. Reaction mixture was stirred for 15 min and usual

workup as described above for the preparation of chiral carbinols (Method A), after chromatographic purification (Si-gel, 2% ethyl acetate - pet. ether) gave pure **14a** (0.520 g) in 87% yield ^{1}H NMR : δ 0.84 (t, 3H), 1.1-1.6 (m, 14H), 4.12 (m, 1H), 5.9 (dd, J_1 = 13.5 Hz, J_2 = 6.1 Hz, 1H), 6.21 (d, J = 13.5 Hz, 1H). IR : 3450 cm^{-1}. M$^+$ 204. $[\alpha]_D$ = -64° (c 2, $CHCl_3$). Anal. Calcd. for $C_{11}H_{21}ClO$: C, 64.53; H, 10.34; Found : C, 64.8; H, 10.3%.

Method B : To a freshly prepared LDA [prepared from diisopropylamine (0.303 g, 3 mmol) and n-BuLi (1.1 ml, 3 mmol, 2.98 N in hexane)] in THF (5 ml) was added epoxy chloride **4a** (0.642 g, 3 mmol) in THF (2 ml) at -78°. After 1 h, it was worked up as described in Method B above for the preparation of chiral carbinols. Evaporation of organic layer and purification of the residue by column chromatography (Si-gel, 2% ethyl acetate in pet. ether) gave **14a** (0.503 g) in 82% yield.

(1E,3R,5Z)-1-Chloro-1,5-undecadien-3-ol (14d). Compound **14d** was prepared from **4d** (0.576 g, 3 mmol) in 79% yield. ^{1}H NMR : δ 0.85 (t, 3H), 1.1-1.6 (m, 6H), 1.6-2.5 (m, 4H), 4.0 (m, 1H), 5.1-5.7 (m, 2H), 5.85 (dd, J_1 = 13.5 Hz, J_2 = 6.2 Hz, 1H), 6.1 (d, J = 13.5 Hz, 1H). IR : 3450 cm^{-1}. M$^+$ 202, 167. $[\alpha]_D$ = +19.0 (c 0.6, $CHCl_3$). Anal. Calcd. for $C_{11}H_{19}ClO$: C, 65.17; H, 9.44; Found : C, 65.4; H, 9.25%.

(1E,3S)-1-Chloro-3,7-dimethyl-1,6-octadien-3-ol (14l). Compound **14l** was prepared from **4l** (0.564 g, 3 mmol) in 82% yield. ^{1}H NMR : δ 1.28 (s, 3H), 1.5-1.75 (m, 8H), 1.8-2.1 (m, 2H), 4.93-5.1 (m, 1H), 5.84 (d, J = 14.0 Hz, 1H), 6.12 (d, J = 14.0 Hz, 1H). IR : 3400 cm^{-1}. M$^+$ 185, 153. $[\alpha]_D$ = -15.5° (c 2.6, $CHCl_3$). Anal. Calcd. for $C_{10}H_{17}ClO$: C, 63.64; H, 9.08; Found : C, 63.79; H, 9.1%.

Opening of 2,3-Epoxygeranyl chloride (4l)

With 1 eq. of n-BuLi : Treatment of **4l** (0.564 g, 3 mmol) with 1 eq. of n-BuLi (1 ml, 3 mmol, 2.98 N in hexane) in THF at -33° gave a crude mixture (0.520 g) in 92% yield. Chromatographic purification (Si-gel, 2% ethyl acetate - pet. ether) gave **4l** (0.195 g), **14l** (0.230 g) and **21** (0.085 g).

With 3 eq. of n-BuLi : Compound **4l** (0.560 g, 3 mmol) on treatment with 3 eq. of n-BuLi (3 ml, 9 mmol, 2.98 N in n-hexane) under the similar conditions described above gave **21** (0.350 g) in 77% yield.

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