C-24 Stereochemistry of Marine Sterols: (22*E*)-24-(Isopropenyl)-22-dehydrocholesterol and 24-Isopropenylcholesterol

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The C-24 configuration of (22*E*,24ξ)-24-isopropenyl-22-dehydrocholesterol (1), which was recently isolated from the Colombian Caribbean sponge, *Topsentia ophiraphidites*, was investigated. Synthesis of the stereodefined (24*R*)- and (24*S*)-(22*E*)-24-isopropenyl-22-dehydrocholesterols (1a, 1b) followed by ^{1}H- and ^{13}C-NMR data comparison of these sterols established the (24*R*)-configuration of 1. In addition, (24*R*)- and (24*S*)-24-isopropenylcholesterols (2a and 2b) were also synthesized and their NMR data are provided. The C-24 configurations of the samples of 24-isopropenylcholesterol reported previously are discussed.

Key words marine sterol; 24-isopropenyl-22-dehydrocholesterol; *Topsentia ophiraphidites*; 24-isopropenylcholesterol; nervesterol

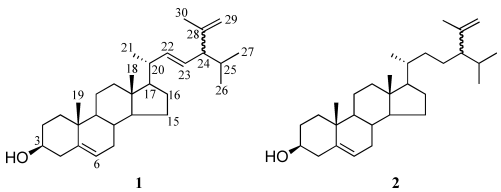
We have recently isolated a series of multiply alkylated sterols, including a new C_{31}-sterol, ophirasterol [(22*E*)-24-(1-buten-2-yl)cholesta-5,22-dien-3β-ol], from the Caribbean sponge, *Topsentia ophiraphidites*.[1] Among these sterols, the C-24 configurations of ophirasterol,[1] (22*E*)-24-ethyl-24-methyl-22-dehydrocholesterol and 24-ethyl-24-methylcholesterol were determined to be *R*, *R* and *S*, respectively, through synthetic and X-ray studies.[2] We have now investigated the C-24 configuration of (22*E*,24ξ)-24-isopropenyl-22-dehydrocholesterol **1** (Fig. 1). The isolation of **1** was reported also from other marine sources and a terrestrial plant (*vide infra*). NMR comparison of the natural **1** and synthetic, stereodefined (24*R*)- and (24*S*)-samples led to the stereochemical assignment of **1**. Stereochemically defined (24*R*)- and (24*S*)-24-isopropenylcholesterols (**2a**, **b**) were also synthesized and the C-24 configurations of the samples of (24ξ)-24-isopropenylcholesterol **2** reported previously are discussed.

(24*R*)- and (24*S*)-(22*E*)-Δ^{22}-24-isopropenylcholesterols (**1a**, **b**) and (24*S*)- and (24*R*)-24-isopropenylcholesterols (**2a**, **b**) were synthesized stereoselectively in a route involving orthoester Claisen rearrangement (Chart 1). The known starting materials, (22*R*)- and (22*S*)-allylic alcohols **3a** and **3b**,[3] were used in our recent synthesis of ophirasterol and its C-24 epimer.[1] Exposure of **3a** to a condition of orthoester Claisen rearrangement (triethyl orthopropionate and a catalytic amount of propionic acid in refluxing xylene) gave the (24*R*)-rearranged ester **4a** as a *ca.* 1 : 1 mixture at the C-28 position, as revealed by ^{13}C-NMR analysis of **4a**. The configuration at C-24 of **4a** was assigned as *R* from the previous examples of orthoester Claisen rearrangements of steroidal (23*E*)-23-en-22-ols.[3—5] The rearranged product **4a** was reduced with $LiAlH_4$ to give the primary alcohol **5a**, dehydration of which gave the (24*R*)-exomethylene **6a**. Acidic treatment of **6a** furnished the (24*R*)-sterol **1a**. The (24*S*)-epimer **1b** was synthesized in the same manner from the (22*S*)-allylic alcohol **3b** *via* the intermediates, the rearranged ester **4b**, the primary alcohol **5b**, and the exomethylene **6b**.

Hydrogenation of the primary alcohol **5a** followed by dehydration gave the 22-saturated exomethylene **7a**. Compound **7a** furnished (24*S*)-24-isopropenylcholesterol **2a** by regeneration of the Δ^5-3β-hydroxy system. Similarly, (24*S*)-alcohol **5b** was converted to (24*R*)-epimer **2b** *via* (24*R*)-exomethylene **7b**.

With stereodefined (24*R*)- and (24*S*)-(22*E*)-Δ^{22}-24-isopropenylcholesterols (**1a**, **b**) in hand, their NMR data were compared with those of natural sample **1**. The ^{1}H and ^{13}C signals were assigned by 2D-NMR studies including heteronuclear multiple-bond correlation (HMBC) spectra. The high-resolution ^{1}H-NMR data (Table 1) were useful for distinguishing the epimers and considerable chemical shift difference ($\Delta\delta$ 0.021) was observed in the 21-H_3 signals (δ 1.025 for **1a**, δ 1.004 for **1b**). The olefinic protons, H-22 and H-23, also showed diagnostic difference as illustrated in Fig. 2. The H-22 and H-23 signals of (24*S*)-compound **1b** showed a larger chemical shift difference than those of (24*R*)-epimer **1a**. The H-22 and H-23 signals of ophirasterol and its C-24 epimer displayed an essentially identical pattern.[1]

The ^{13}C-NMR data (Table 2) of **1a** and **1b** are reported for the first time. The C-16 signal showed the largest chemical shift difference (0.47 ppm) with the C-16 of **1a** being more shielded, as shown in a graphic representation of ^{13}C comparison of the epimers (Fig. 3). The C-17 resonance showed the second largest difference (0.22 ppm) with the C-17 of **1b** being more shielded. This aptitude is the same as that observed for ophirasterol and its C-24 epimer.[1] Analogously, the C-16 signals of stigmasterol and crinosterol resonated at lower field than the corresponding C-24 epimers, poliferasterol and brassicasterol.[6]



1 **2**

Fig. 1. Structures of (22*E*,24ξ)-24-Isopropenyl-22-dehydrocholesterol (**1**) and (24ξ)-24-Isopropenylcholesterol (**2**)

The C-24 configuration of **1** isolated from *Topsentia ophiraphidites* was established to be *R* in the present study.

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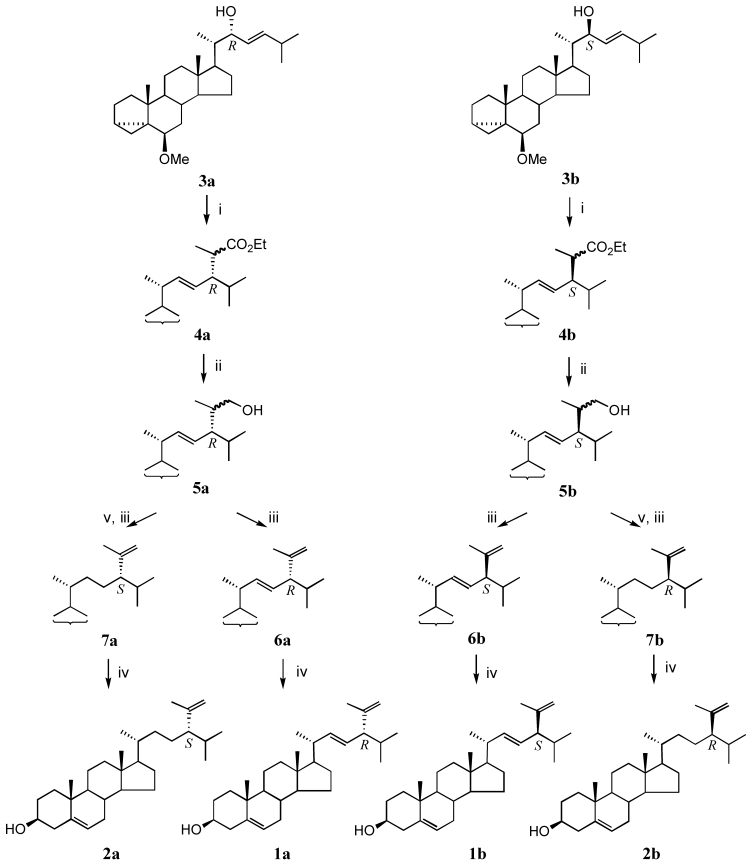

Reagents: i) $EtC(OEt)_3$, propionic acid , ii) $LiAlH_4$, iii) 2-$NO_2C_6H_4SeCN$, nBu_3P; H_2O_2, iv) *p*-TsOH/aq. dioxane, v) H_2, Pd/C

Chart 1. Synthesis of 24-Isopropenylsterols **1a**, **1b**, **2a** and **2b**

Table 1. ^{1}H-NMR Data (500 MHz, in $CDCl_3$) for Compounds **1**, **1a** and **1b**

No.	**1**	**1a** (24*R*)	**1b** (24*S*)
3	3.52 (m)	3.52 (m)	3.52 (m)
6	5.35 (br d, 5.2)	5.35 (br d, 5.2)	5.35 (br d, 5.3)
18	0.689 (s)	0.690 (s)	0.697 (s)
19	1.008 (s)	1.008 (s)	1.010 (s)
21	1.025 (d, 6.6)	1.025 (d, 6.6)	1.004 (d, 5.8)
22	5.229 (m)	5.229 (m)	5.203 (dd, 15.1, 8.1)
23	5.229 (m)	5.229 (m)	5.263 (dd, 15.1, 8.4)
26	0.820 (d, 7.2)	0.821 (d, 7.1)	0.823 (d, 6.7)
27	0.835 (d, 6.9)	0.835 (d, 6.9)	0.837 (d, 6.7)
29	4.66 (br s), 4.68 (br s)	4.66 (br s), 4.68 (br s)	4.66 (br s), 4.69 (br s)
30	1.646 (s)	1.645 (s)	1.651 (s)

The ^{1}H- and ^{13}C-NMR data of the marine sterol **1** were in excellent agreement with those of **1a** (Tables 1, 2), thus establishing the C-24 configuration of the natural sterol **1** as *R*. Melting point of **1** (149—151 °C, measured after the sample (143—146 °C) described in our previous paper[1]) was recrystallized from MeOH once more) further confirmed this assignment (mp: 150—152 °C for **1a**; 174—176 °C for **1b**). Kikuchi *et al.* reported the isolation of (22*E*,24ξ)-24-isopropenyl-22-dehydrocholesterol (nervisterol) from the Orchidaceous plant, *Nervilia purpurea*.[7] The C-24 configuration of nervisterol was now assigned as *S* on the basis of the ^{1}H-NMR data comparison and the reported mp (175—177 °C). (22*E*)-24-Isopropenyl-22-dehydrocholesterol isolated from

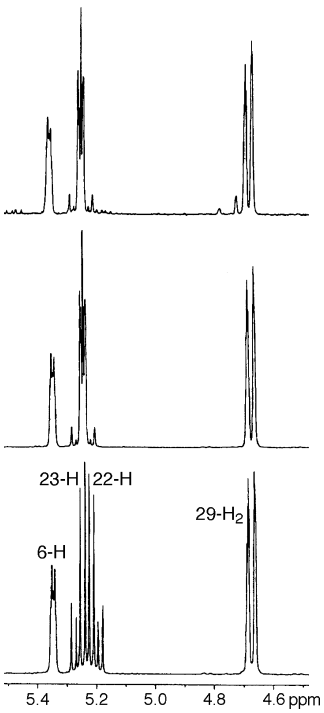

Fig. 2. Partial ^{1}H-NMR Spectra (500 MHz, $CDCl_3$) of the Sample **1** from *Topsentia ophiraphidites* (Top), **1a** (Middle) and **1b** (Bottom)

Table 2. ^{13}C-NMR Data (125 MHz, in $CDCl_3$) for Compounds **1**, **1a**, **1b**, **2a** and **2b**

No.	**1**	**1a** (24*R*)	**1b** (24*S*)	**2a** (24*S*)	**2b** (24*R*)
1	37.25	37.26	37.26	37.24	37.24
2	31.67	31.66	31.67	31.65	31.65
3	71.81	71.78	71.80	71.79	71.80
4	42.31	42.31	42.31	42.29	42.32
5	140.74	140.75	140.76	140.74	140.74
6	121.69	121.67	121.68	121.71	121.72
7	31.89	31.89	31.90	31.89	31.88
8	31.89	31.89	31.90	31.89	31.90
9	50.15	50.16	50.16	50.11	50.10
10	36.51	36.51	36.51	36.49	36.49
11	21.06	21.06	21.07	21.06	21.08
12	39.65	39.66	39.67	39.72	39.78
13	42.28	42.28	42.26	42.27	42.29
14	56.78	56.79	56.84	56.72	56.76
15	24.30	24.30	24.37	24.27	24.27
16	28.43	28.43	28.90	28.13	28.16
17	56.12	56.13	55.91	55.87	56.18
18	12.03	12.04	12.02	11.82	11.84
19	19.39	19.39	19.38	19.39	19.39
20	40.11	40.11	40.30	36.20	35.47
21	21.19	21.19	21.29	19.06	18.59
22	137.75	137.75	137.80	34.17	33.94
23	128.58	128.59	128.71	26.27	26.20
24	58.44	58.44	58.57	55.49	55.02
25	29.18	29.18	29.33	30.23	30.23
26	20.14	20.14	20.24	20.85	20.85
27	20.75	20.76	20.78	21.50	21.61
28	148.25	148.22	148.35	147.36	147.08
29	110.10	110.10	110.08	111.86	112.03
30	20.34	20.34	20.47	18.91	18.51

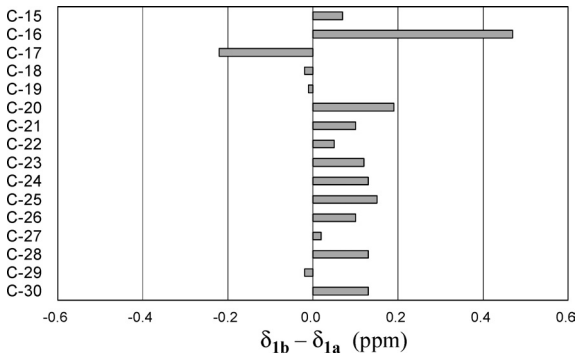

Fig. 3. Comparison of the ^{13}C-NMR Data of **1a** and **1b**

the sponge *Pseudoaxinyssa* sp. was reportedly a C-24 epimeric mixture.[8)]

The ^{1}H- and ^{13}C-NMR data of the 22-saturated 24-isopropenylcholesterols **2a** and **2b** are listed in Tables 3 and 2, respectively. In the ^{1}H-NMR spectra the 21-H_3 ($\Delta\delta$ 0.013) and 18-H_3 ($\Delta\delta$ 0.008) signals showed small differences and these differences can be used for determination of the C-24 configuration when accurate ^{1}H-NMR data are available. The ^{13}C-NMR data, reported for the first time in this paper, seemed to be more diagnostic than the ^{1}H-NMR data. The signals of C-20 ($\Delta\delta$ 0.73), C-21, C-24 and C-30 exhibited more than 0.3 ppm chemical shift differences between epimers, as shown in Fig. 4.

Kikuchi *et al.* reported the isolation of (24*S*)-24-isopropenylcholesterol from *N. purpurea*,[7,9)] the 24*S* configuration of which was assigned by converting it to clionasterol

Table 3. ^{1}H-NMR Data (500 MHz, in $CDCl_3$) for Compounds **2a** and **2b**[16)]

No.	**2a** (24*S*)	**2b** (24*R*)
3	3.53 (m)	3.52 (m)
6	5.35 (br d, 5.1)	5.35 (br d, 5.6)
18	0.665 (s)	0.673 (s)
19	1.006 (s)	1.007 (s)
21	0.922 (d, 6.6)	0.909 (d, 6.4)
26	0.802 (d, 6.1)	0.799 (d, 6.4)
27	0.910 (d, 5.9)	0.904 (d, 6.4)
29	4.60 (br s), 4.74 (br s)	4.61 (br s), 4.74 (br s)
30	1.564 (s)	1.561 (s)

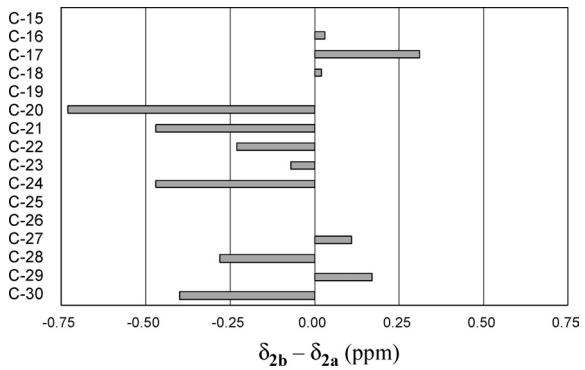

Fig. 4. Comparison of the ^{13}C-NMR Data of **2a** and **2b**

((24*S*)-24-ethylcholesterol). The reported ^{1}H-NMR values of the plant sterol are in good agreement with those of **2a**, thus confirming the previous stereochemical assignment. Catalan *et al.* reported the isolation of a stereochemically pure (24*S*)-24-isopropenylcholesterol **2a** from the sponge, *Aplysina fistularis*, the C-24 configuration of which was assigned on the basis of the ^{1}H-NMR data described above.[10,11)] (24*S*)-24-Isopropenylcholesterol was also isolated from the sponge, *Pseudoaxinyssa* sp.[10)] In contrast, 24-isopropenylcholesterol isolated from a marine Chrysophyte[12)] could be assigned as (24*R*)-compound **2b**, because the reported ^{1}H-NMR data were in excellent agreement with those of **2b**. Isolation of (24ξ)-24-isopropenylcholesterol **2** from higher plants, *Anoectochilus koshunensis* (Orchidaceae)[13)] and *Azadirachta indica* (Meliacea),[14)] was recorded without relevant data to assign the C-24 configuration.

In conclusion, we have synthesized and provided detailed ^{1}H- and ^{13}C-NMR data for 24*R*- and 24*S*-epimers of **1** and **2**, which allowed us to establish the C-24 configuration of **1** isolated from *T. ophiraphidites*. The same 24β orientation (with regard to the 1-buten-2-yl and isopropenyl substituents) of ophirasterol and (22*E*,24*R*)-24-isopropenyl-22-dehydrocholesterol found in *T. ophiraphidites* would support the view that **1a** is a biosynthetic precursor of ophirasterol in the sponge.[1)] The present study also determined the 24*S* configuration of nervisterol. It is notable that (24*S*)-24-isopropenylcholesterol **2a** cannot be a precursor of nervisterol **1b** in spite of their co-occurrence in the *N. purpurea* plant, since their C-24 orientations are different from each other. Stoilov *et al.* reported experimental evidence that fucosterol/isofucosterol is a biosynthetic precursor of the 24-isopropenylcholesterol in the sponge, *Pseudoaxinissa* sp.[15)] Neither **2a** nor **2b** was detected in GLC and HPLC analysis of the sterol mixture ob-

tained from *T. ophiraphidites*.

Experimental

General Melting points were determined by a Yazawa BY-1 hot-stage apparatus and are uncorrected. Optical rotations were measured with a JASCO DIP-360 polarimeter. ^{1}H- and ^{13}C-NMR spectra were recorded on a Bruker DRX500 (500 MHz for ^{1}H and 125 MHz for ^{13}C) or JEOL JNM-LA400 (400 MHz for ^{1}H and 100 MHz for ^{13}C) spectrometer in $CDCl_3$ solution. $CDCl_3$ signal was used as a reference (δ 77.0) for ^{13}C-chemical shifts. EI-MS (70 eV) and HR-EI-MS spectra were obtained on a JEOL JMS-700 spectrometer. A part of ^{1}H-NMR data, δ: 0.44 (dd, J=8.0, 5.1 Hz, 4α-H), 0.65 (t, J=4.4 Hz, 4β-H), 2.78 (br t, J=2.7 Hz, 6-H), 3.32 (s, OMe), for compounds with a 6β-methoxy-3α,5-cyclo structure are not described, since they were common to all such compounds.

(22*E*,24*R*)-24-Isopropenyl-6β-methoxy-3α,5-cyclo-5α-cholest-22-ene (6a) A solution of 22*R*-alcohol **3a**[1,3] (70 mg, 169 mmol) (^{1}H-NMR δ: 4.12 (dd, J=7.4, 3.4 Hz, 22-H)), triethyl orthopropionate (100 μl, 507 μmol) and propionic acid (7.5 μl, 101 μmol) in xylene (2.1 ml) was heated at reflux under N_2 for 1 h. After removal of most of the solvent on a rotary evaporator, the residue was chromatographed on silica gel with hexane–ether (20 : 1) to give the rearranged product **4a** (71 mg) as oil. ^{1}H-NMR δ: 0.707/0.718 (s, 18-H$_3$), 1.224/1.243 (t, J=7.1 Hz, OCH$_2$C$\underline{\text{H}}_3$), 4.02—4.16 (m, OC$\underline{\text{H}}_2$CH$_3$), 4.94—5.29 (m, 22-H, 23-H). ^{13}C-NMR δ: 59.91/59.98 (C-29), 124.53/125.20 (C-23), 140.31/141.17 (C-22), 176.21/176.74 (C=O).

$LiAlH_4$ (16 mg, 142 μmol) was added to a solution of **4a** (71 mg) at 0 °C under N_2 and the mixture was stirred for 30 min. The solution was diluted with moist ether and then a small amount of water. The supernatant solution was filtered through a pad of Celite and concentrated *in vacuo*. The residue was chromatographed on silica gel with hexane–AcOEt (10 : 1) to give **5a** (48 mg, 105 mmol) as oil. ^{1}H-NMR δ: 0.73 (s, 18-H$_3$), 3.33—3.65 (m, 29-H$_2$), 5.05—5.27 (m, 22-H, 23-H). ^{13}C-NMR δ: 67.17/67.57 (C-29), 126.56/126.70 (C-23), 139.70/140.16 (C-22).

2-Nitrophenyl selenocyanate (71.5 mg, 315 μmol) and tri-*n*-butylphosphine (79 μl, 315 mmol) were added to a solution of **5a** (48 mg, 105 μmol) in THF (2.5 ml) and the mixture was stirred for 1 h under N_2. 30% H_2O_2 (1.0 ml) was added and the mixture was stirred for another 1.5 h. The mixture was diluted with ether and brine, and the organic layer was washed with saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, and concentrated *in vacuo*. The residue was chromatographed on silica gel with hexane–ether (20 : 1) to give **6a** (38 mg, 51%, 3 steps) as oil. ^{1}H-NMR δ: 0.73 (s, 18-H$_3$), 0.82 (d, J=6.6 Hz, 26-H$_3$), 0.83 (d, J=6.6 Hz, 27-H$_3$), 1.02 (d, J=6.4 Hz, 21-H$_3$), 1.02 (s, 19-H$_3$), 1.65 (s, 30-H$_3$), 2.19 (m, 25-H), 4.66 (br s, 29-Ha), 4.68 (br s, 29-Hb), 5.24 (m, 22-H, 23-H). ^{13}C-NMR δ: 12.42, 13.06, 19.29, 20.13, 20.34, 20.74, 21.19, 21.44, 22.74, 24.19, 24.95, 28.55, 29.15, 30.46, 33.33, 35.05, 35.23, 40.14, 40.19, 42.71, 43.37, 48.04, 56.26, 56.54, 58.43, 82.39, 110.09, 128.48, 137.82, 148.24. *Anal.* Calcd for $C_{31}H_{50}O$: C, 84.87; H, 11.49. Found: C, 84.58; H, 11.51.

(22*E*,24*R*)-24-Isopropenylcholesta-5,22-dien-3β-ol (1a) A solution of **6a** (37 mg, 84 μmol) in dioxane (1.2 ml) and H_2O (0.40 ml) containing *p*-TsOH·H_2O (64 μg, 3.4 μmol) was heated at 105 °C for 3 h. Extractive (ether) work-up gave a crude product which was chromatographed on silica gel with hexane–AcOEt (7 : 1) to give **1a** as a solid. Recrystallization from MeOH afforded **1a** (24 mg, 67%) as white plates, mp 150—152 °C. $[\alpha]_D^{25}$ −41.7° (c=2.59, $CHCl_3$). ^{1}H-NMR data: see Table 1. ^{13}C-NMR data: see Table 2. *Anal.* Calcd for $C_{30}H_{48}O$: C, 84.84; H, 11.39. Found: C, 84.76; H, 11.41.

(22*E*,24*S*)-24-Isopropenyl-6β-methoxy-3α,5-cyclo-5α-cholest-22-ene (6b) (22*S*)-Alcohol **3b**[1,3] (131 mg, 316 μmol) (^{1}H-NMR δ: 4.21 (br t, J=5.2 Hz, 22-H)) was converted to **6b** (59 mg, 42%, 3 steps) according to the procedure described for **3a**. The intermediate **4b**: oil, ^{1}H-NMR δ: 0.710/0.717 (s, 18-H$_3$), 1.232/1.244 (t, J=7.1 Hz, OCH$_2$C$\underline{\text{H}}_3$), 3.99—4.15 (m, OC$\underline{\text{H}}_2$CH$_3$), 4.96—5.25 (m, 22-H, 23-H). ^{13}C-NMR δ: 59.80/59.97 (C-29), 124.80/125.17 (C-22), 140.35/141.03 (C-23), 176.18/176.61 (C=O). **5b**: oil, ^{1}H-NMR δ: 0.72 (s, 18-H$_3$), 3.36—3.63 (m, 29-H$_2$), 5.04—5.26 (m, 22-H, 23-H), ^{13}C-NMR δ: 67.16/67.47 (C-29), 126.78/126.90 (C-23), 139.65/140.00 (C-22). **6b**: mp 116—117 °C (recrystallized from MeOH), ^{1}H-NMR δ: 0.73 (s, 18-H$_3$), 0.82 (d, J=6.6 Hz, 26-H$_3$), 0.84 (d, J=6.6 Hz, 27-H$_3$), 1.00 (d, J=6.6 Hz, 21-H$_3$), 1.02 (s, 19-H$_3$), 1.65 (s, 30-H$_3$), 2.18 (m, 25-H), 4.66 (br s, 29-Ha), 4.68 (br s, 29-Hb), 5.23 (m, 22-H, 23-H), ^{13}C-NMR δ: 12.41, 13.07, 19.28, 20.20, 20.50, 20.78, 21.29, 21.43, 22.74, 24.28, 24.95, 29.02, 29.29, 30.46, 33.33, 35.06, 35.22, 40.15, 40.38, 42.68, 43.37, 48.03, 56.04, 56.55, 56.59, 58.59, 82.39, 110.06, 128.64, 137.86, 148.36. *Anal.* Calcd for $C_{31}H_{50}O$: C, 84.87; H, 11.49. Found: C, 84.58; H, 11.51.

(22*E*,24*S*)-24-Isopropenylcholesta-5,22-dien-3β-ol (1b) Compound **6b** (52 mg, 118 μmol) was converted to **1b** (43 mg, 87%) according to the procedure described above for the conversion of **6a** to **1a**. **1b**: white needles, mp 174—176 °C. $[\alpha]_D^{25}$ −46.3° (c=2.07, $CHCl_3$). ^{1}H-NMR data: see Table 1. ^{13}C-NMR data: see Table 2. *Anal.* Calcd for $C_{30}H_{48}O$: C, 84.84; H, 11.39. Found: C, 84.92; H, 11.69.

(24*S*)-24-Isopropenyl-6β-methoxy-3α,5α-cyclocholestane (7a) A solution of **5a** (37.5 mg, 82.1 μmol) in AcOEt (1.0 ml) was hydrogenated in the presence of 10% Pd/C (15 mg) overnight. The catalyst was filtered off through a pad of Celite and the filtrate was concentrated *in vacuo*. The residue was chromatographed on silica gel with hexane–ether (20 : 1) to give the hydrogenated product (37 mg, 81.3 μmol) as an oil.

2-Nitrophenyl selenocyanate (55 mg, 244 μmol) and *n*-tributylphosphine (61 μl, 244 μmol) were added to a solution of the hydrogenated product (37 mg, 81.3 μmol) in THF (2.0 ml) and the mixture was stirred for 1 h under N_2. 30% H_2O_2 (1.0 ml) was added and the mixture was stirred for another 1 h. The mixture was diluted with ether and brine. The organic phase was washed with saturated aqueous $NaHCO_3$ and brine, dried over Na_2SO_4, and concentrated *in vacuo*. The residue was chromatographed on silica gel with hexane–ether (20 : 1) to give **7a** (22 mg, 60%, 2 steps) as oil. ^{1}H-NMR δ: 0.70 (s, 18-H$_3$), 0.80 (d, J=6.1 Hz, 26-H$_3$), 0.91 (d, J=6.1 Hz, 27-H$_3$), 0.92 (d, J=6.6 Hz, 21-H$_3$), 1.02 (s, 19-H$_3$), 1.56 (s, 30-H$_3$), 4.60 (br s, 29-Hb), 4.74 (br s, 29-Hb). ^{13}C-NMR δ: 12.20, 13.05, 18.88, 18.90, 19.29, 20.85, 21.48, 21.52, 22.77, 24.17, 24.96, 26.30, 28.24, 30.23, 30.46, 33.34, 34.15, 35.04, 35.28, 36.24, 40.24, 42.73, 43.37, 48.02, 55.50, 56.06, 56.50, 56.55, 82.43, 111.86, 147.37. HR-EI-MS m/z 440.4062 [M$^+$]; $C_{31}H_{52}O$ requires 440.4018.

(24*S*)-24-Isopropenylcholest-5-en-3β-ol (2a) A solution of **7a** (22 mg, 49.2 μmol) in dioxane (0.60 ml) and H_2O (0.20 ml) containing *p*-TsOH·H_2O (374 mg, 1.97 μmol) was heated at 105 °C for 2 h. Extractive (ether) work-up gave a crude product which was chromatographed on silica gel with hexane–AcOEt (7 : 1) to give **2a** as a solid. Recrystallization from MeOH afforded **2a** (12 mg, 67%) as white plates, mp 134—135 °C. $[\alpha]_D^{25}$ −37.6° (c=1.29, $CHCl_3$). ^{1}H-NMR data: see Table 3. ^{13}C-NMR data: see Table 2. *Anal.* Calcd for $C_{30}H_{50}O$: C, 84.44; H, 11.81. Found: C, 84.36; H, 12.01.

(24*R*)-24-Isopropenyl-6β-methoxy-3α,5-cyclo-5α-cholestane (7b) Compound **5b** (26 mg, 56.7 μmol) was converted to **7b** (14 mg, 58%, 2 steps) according to the procedure described for **5a**. **7b**: oil. ^{1}H-NMR δ: 0.71 (s, 18-H$_3$), 0.80 (d, J=6.3 Hz, 26-H$_3$), 0.90 (d, J=6.6 Hz, 27-H$_3$), 0.91 (d, J=6.5 Hz, 21-H$_3$), 1.02 (s, 19-H$_3$), 1.56 (s, 30-H$_3$), 4.61 (br s, 29-Ha), 4.74 (br s, 29-Hb). ^{13}C-NMR δ: 12.23, 13.04, 18.51, 18.56, 19.30, 20.85, 21.51, 21.62, 22.77, 24.17, 24.96, 26.26, 28.27, 30.23, 30.46, 33.33, 33.92, 35.00, 35.29, 35.54, 40.28, 42.77, 43.37, 47.99, 55.04, 56.35, 56.50, 56.55, 82.42, 112.30, 147.10. HR-EI-MS m/z 440.4038 [M$^+$]; $C_{31}H_{52}O$ requires 440.4018.

(24*R*)-24-Isopropenylcholest-5-en-3β-ol (2b) Compound **7b** (14 mg, 31.8 mmol) was converted to **2b** (10 mg, 74%) in the same manner as described for the conversion of **6a** to **1a**. **2b**: white needles; mp 139—140 °C. $[\alpha]_D^{25}$ −37.8° (c=0.98, $CHCl_3$). ^{1}H-NMR data: see Table 3. ^{13}C-NMR data: see Table 2. *Anal.* Calcd for $C_{30}H_{50}O$: C, 84.44; H, 11.81. Found: C, 84.18; H, 11.86.

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