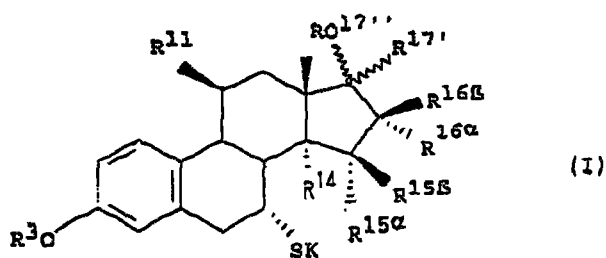


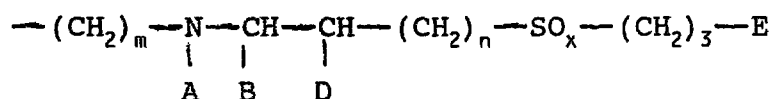
7 α -(ξ -Aminoalkyl)-estratrienes, Process for their Production,
 Pharmaceutical Preparations That Contain These
 7 α -(ξ -Aminoalkyl)-estratrienes as well as Their Use for
 the Production of Pharmaceutical Agents

This invention relates to substituted 7 α -(ξ -aminoalkyl)-estratrienes of general formula I



in which

side chain SK is a radical of partial formula



whereby m is 4, 5 or 6,

n is 0, 1 or 2,

x is 0, 1 or 2,

A is a hydrogen atom or a C_{1-5} alkyl group,

B and D each are a hydrogen atom, or

A and B together are an alkylene group $\text{---}(\text{CH}_2)_p\text{---}$ with
 $p = 2, 3, 4$ or 5, and D is a hydrogen atom or

A and D together are an alkylene group $\text{---}(\text{CH}_2)_q\text{---}$ with
 $q = 2, 3$ or 4, and B is a hydrogen atom, and

E is an unsubstituted ethyl radical or an ethyl radical that is fluorinated in one to five places, or terminal substituent $-(CH_2)_3-E$ in the side chain is replaced by an optionally substituted aryl or heteroaryl radical, which is bonded directly or via a mono-, di- or trimethylene group to the sulfur atom,

R^3 is a hydrogen atom, a hydrocarbon radical with up to 8 carbon atoms or a radical of partial formula $R^{3'}-C(O)-$, in which $R^{3'}$ is a hydrogen atom or a hydrocarbon radical with up to 8 carbon atoms or a phenyl radical,

R^{11} is a hydrogen atom, a halogen atom or a nitrooxy group $-O-NO_2$,

R^{14} , $R^{15\alpha}$, $R^{15\beta}$, $R^{16\alpha}$ and $R^{16\beta}$ each are a hydrogen atom or R^{14} and $R^{15\alpha}$ are an additional bond or a methylene bridge, or $R^{15\beta}$ is a methyl group and $R^{15\alpha}$ is a hydrogen atom, or $R^{15\alpha}$ and $R^{15\beta}$ in each case are a methyl group, or $R^{15\beta}$ and $R^{16\beta}$ together are a methylene bridge, or $R^{16\alpha}$ or $R^{16\beta}$ is a halogen atom or $R^{16\alpha}$ and $R^{16\beta}$ together are a methylenidene group and the remaining substituents R^{14} , $R^{15\alpha}$, $R^{15\beta}$, $R^{16\alpha}$ and $R^{16\beta}$ are each a hydrogen atom,

$R^{17'}$ in α - or β -position is a hydrogen atom, a C_{1-5} alkyl, C_{2-5} alkenyl or C_{2-5} alkynyl group or a trifluoromethyl group and

$R^{17''}$ is a hydrogen atom or a radical of partial formula $R^{17'''}-C(O)-$, in which $R^{17'''}$ is a hydrogen atom or a hydrocarbon radical with up to 8 carbon atoms, or, if $R^{17'}$ is in α -position, $R^{17'}$ together with R^{14} means an ethano bridge,

provided that unless A and B together stand for $-(CH_2)_p-$ or A and D together stand for $-(CH_2)_q-$, at least one of substituents R^{11} , R^{14} , $R^{15\alpha}$, $R^{15\beta}$, $R^{16\alpha}$ and $R^{16\beta}$ is not a hydrogen atom, as well as their physiologically compatible addition salts with organic and inorganic acids.

In addition, this invention relates to these compounds of general formula I as well as their physiologically compatible addition salts with pharmaceutical preparations that contain organic and inorganic acids as well as their use for the production of pharmaceutical agents.

In the compounds of general formula I, the nitrogen atom in the side chain is preferably separated by 5 methylene groups from carbon atom 7 of the steroid skeleton.

If A stands for an alkyl group with up to 5 carbon atoms, this is a methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tert-butyl, pentyl, isopentyl, or neopentyl group; a methyl group is preferred as A.

Index n can assume the value 0, 1 or 2, whereby if A is a hydrogen atom or an alkyl group with up to 5 carbon atoms, value 1 is preferred for n, so that the nitrogen atom and the sulfur atom are separated by 3 methylene groups.

The nitrogen atom can be a component of a 4- to 7-membered or 5- to 7-membered heterocycle, which is substituted in 2- or 3-position with the radical of side chain $-(CH_2)_n-SO_x-(CH_2)_3-E$.

Preferably, A and B together are a trimethylene group, i.e., together with the nitrogen atom and its adjacent carbon atom, they form a pyrrolidine ring that is substituted in 2-position.

In the latter case, value 0 is preferred for n and value 0 is preferred for x.

The sulfur atom in the side chain can be present as a simple sulfur bridge (sulfide), as sulfone or sulfoxide. The sulfides are preferred.

As radical E, an unsubstituted ethyl radical or an ethyl radical that is fluorinated in one to five places is suitable; the perfluorine radical is preferred for E.

If terminal substituent $-(CH_2)_3-E$ in the side chain is replaced by an optionally substituted aryl or heteroaryl radical, which is bonded directly or via a mono-, di- or trimethylene group to the sulfur atom, the aryl radical is preferably a phenyl radical; in the case of a heteroaryl radical, this is preferably a 2-furyl or 2-thienyl radical. As a substituent to this aryl or heteroaryl radical, for example, this can be a pentafluoroethyl or trifluoromethyl group, preferably a trifluoromethyl group, and this in turn will preferably be in the 4-position of a phenyl radical. A 2-furyl or 2-thienyl radical is preferably separated from the sulfur atom by a methylene group.

Substituent R^3 at the 3-oxygen atom is primarily a hydrogen atom. The hydroxy group can also, however, be etherified with a

straight-chain or branched-chain, saturated or unsaturated hydrocarbon radical with up to 8 carbon atoms, such as, e.g., a methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tert-butyl, pentyl, isopentyl, neopentyl, heptyl, hexyl or octyl radical or esterified with an acyl radical $R^{3'}-C(O)-$, in which $R^{3'}$ is a hydrogen atom or a hydrocarbon radical with up to 8 carbon atoms or a phenyl radical.

Substituents R^{11} can be a hydrogen atom, a halogen atom (F, Cl, Br, I) or a nitrooxy group; a fluorine atom is preferred.

If R^{11} stands for a hydrogen atom or if A and B together do not stand for $-(CH_2)_p-$ or if A and D together do not stand for $-(CH_2)_q-$, the D-ring exhibits a substitution from the group 14,15-double bond, 14 α ,15 α -methylene, 15 β -methyl, 15,15-dimethyl, 15 β ,16 β -methylene, 16 α - or 16 β -halogen and of these especially 16 α -fluorine, 16-methylidene or 14 α ,17 α -ethano. A 15 β -methyl group or 16 α -fluorine atom preferably can be mentioned.

$R^{17'}$ can be in α - or β -position.

In the case of a C_{1-5} alkyl group, this is a methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tert-butyl, pentyl, isopentyl or neopentyl group. As a C_{2-5} alkenyl group, for example, the vinyl or allyl radical can be mentioned. Typical representatives of a C_{2-5} alkynyl group are the ethynyl and 1-propynyl radicals.

If $R^{17'}$ is in α -position, especially a hydrogen atom, a methyl or trifluoromethyl group or an ethano bridge that is formed together with R^{14} stands for this.

For $R^{17'}$ in β -position, primarily a hydrogen atom and a methyl group can be mentioned.

Especially those compounds of general formula I are preferred in which side chain SK is either a radical of partial formula $--(CH_2)_5--N(CH_3)--(CH_2)_3--SO_x--(CH_2)_3--C_2F_5$ with $x = 0, 1$ or 2 or $--(CH_2)_5--N(A)--(CHB)--CH_2--S--(CH_2)_3--C_2F_5$ with $A + B = --(CH_2)_3--$. In the latter case, the compounds preferably exhibit a 17α -hydrogen atom.

Inorganic and organic acids, as they are known to one skilled in the art for forming physiologically compatible salts, are suitable for forming acid addition salts. As addition salts with acids, especially hydrochlorides and methanesulfonates can be mentioned.

The compounds below are especially preferred according to the invention:

14,17-Ethano- 7α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

14,17-ethano- 7α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

3,17 β -diacetox-14 α ,17 α -ethano- 7α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene

14,17-ethano- 7α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

17 α -trifluoromethyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β ,16 β -methano-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β ,16 β -methano-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β ,17 α -dimethyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-17 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 α -diol

16 α -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 α -diol

16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol

7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol

7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol

7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

7 α -{5-[(2R)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

17 α -methyl-7 α -{5-[2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -nitrooxy-7 α -(9-[4,4,5,5,5-pentafluoropentanesulfonyl]-nonyl)-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol,

11 β -fluoro-7 α -{5-[N-methyl-N-2-(4,4,5,5,5-pentafluoropentanesulfonyl)-ethylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-hydroxy-estra-1,3,5(10)-trien-17-one

11 β -fluoro-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-hexyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-hexyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -(5-{[N-3-(furan-2-ylmethylthio)-propyl]-N-methyl-amino}-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -(5-{N-methyl-[N-3-(thiophen-2-ylmethylthio)-propyl]-amino}-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[(2R)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol.

The compounds of general formula I represent compounds with very strong antiestrogenic action.

The compounds according to the invention are, on the one hand, pure antiestrogens, or, on the other hand, so-called partial antagonists, i.e., antiestrogens with partial estrogenic action such as tamoxifen or raloxifen. The agonistic, estrogenic action is clearly less pronounced than in tamoxifen, however, in the compounds according to the invention in each case. Unlike tamoxifen, in the case of the partial antagonists of general

formula I, their agonistic, estrogenic action occurs in a tissue-selective manner. The agonistic action especially occurs on bones, in the cardiovascular system and in the CNS (central nervous system). No agonistic action occurs especially on the uterus.

Compounds with antiestrogenic properties, i.e., substances with inhibiting actions relative to estrogens, have already been described extensively.

As the compounds that come closest structurally to the compounds in question here of general formula I, on the one hand, the steroid derivatives that are described in EP-A 0 138 504 can be considered, and of the latter especially 7α -[9-(4,4,5,5,5-pentafluoropentylsulfinyl)-n-nonyl]-estra-1,3,5(10)-triene-3,17 β -diol (EP-A 0 138 504, page 58, penultimate compound). This compound is currently under clinical development for hormone-dependent tumors (breast cancer) and represents the compound that is best known at this time, i.e., the one with the strongest antiestrogenic activity, of these steroid derivatives.

Pharmaceutical compositions that contain sex steroid inhibitors and exhibit a steroidal skeleton, which exhibits a 7α -side chain with the simultaneous presence of at least one other substituent in 14-, 15- or 16-position, are the subject of EP-A 0 376 576 and are also to be considered as the closest prior art.

A considerable number of the most varied compounds -- i.a., those of steroidal origin and those with a 2-phenylindole skeleton -- which act as antiestrogens and/or suppress the estrogen biosynthesis, are disclosed in WO 93/10741.

Other steroidal antiestrogens are described in EP-AS 0 384 842 and 0 629 635, which have an 11β -phenyl radical.

In the compounds according to the invention, there are antiestrogens with stronger antiestrogenic action than the already mentioned 7α -[9-(4,4,5,5,5-pentafluoropentylsulfinyl)-n-nonyl]-estra-1,3,5(10)-triene-3,17 β -diol.

The compounds of general formula I according to this application are distinguished in comparison to the already known steroid derivatives according to EP-A 0 138 504 and EP-A 0 367 576 by novel side chains on carbon atom 7 of the steroid skeleton. This structural modification results in especially greatly antiestrogenically active compounds, as was demonstrated in a transactivation test.

In addition, relative to the compounds of EP-A 0 138 504, the compounds of general formula I are distinguished with respect to the substitution on carbon atom 11 and/or of the D-ring (except in the case that A and B together stand for $-(CH_2)_p-$ or A and D together stand for $-(CH_2)_q-$). In comparison to the compounds of EP-A 0 367 576, the compounds of general formula I on carbon atom 11 and/or in the D ring can carry the same or other substituents.

By the disclaimer in the definition of general formula I, compounds that are described from their scope in non-prepublished DE P 196 22 457 are excluded.

The antiestrogenic action of the compounds according to the invention was determined in transactivation assays [Demirpence, E.; Duchesne, M.-J.; Badia, E.; Gagne, D. and Pons, M.: MVLN

Cells: A Bioluminescent MCF-7-Derived Cell Line to Study the Modulation of Estrogenic Activity; J. Steroid. Molec. Biol. Vol. 46, No. 3, 355-364 (1993) as well as Berry, M.; Metzger, D.; Chambon, P.: Role of the Two Activating Domains of the Estrogen Receptor in the Cell-Type and Promoter-Context Dependent Agonistic Activity of the Anti-estrogen 4-Hydroxytamoxifen; The EMBO Journal Vol. 9, 2811-2818 (1990)].

The HeLa cells are transiently transfected with human estrogen receptor-expression vector (HEGO) and Vit-TK-CAT reporter genes, and the MVLN cells are transfected in a stable manner with reporter gene Vit-TK-LUC. The estrogenic active strength was determined in the presence of 0.1 Nm of estradiol.

The IC₅₀ values for the new compounds lie in the nanomolar range. In the HeLa cell line as well as the MVLN cell line, the following IC₅₀ values are produced for the compounds of Examples 12, 15, 18, 25, 29, 31 and 36 as well as for 7 α -[9-(4,4,5,5,5-pentafluoropentylsulfinyl)-n-nonyl]-estra-1,3,5(10)-triene-3,17 β -diol (execution of test according to the above-indicated

bibliographic references):

Compound	IC ₅₀ [nM]	
	HeLa cells	MVLN cells
Example 12	0.06	2.4
Example 15	0.06	1.4
Example 18	0.05	0.13
Example 25	0.06	0.15
Example 29	0.13	0.2
Example 31	0.1	0.2
Example 36	0.05	0.4
Reference:		
7 α -[9-(4,4,5,5,5-pentafluoro- pentanesulfinyl)-nonyl]-estra- 1,3,5(10)-triene-3,17 β -diol	0.5	6.0

In-vivo tests also confirm the superiority of the compounds according to the invention over 7 α -[9-(4,4,5,5,5-pentafluoropentanesulfinyl)-nonyl]-estra-1,3,5(10)-triene-3,17 β -diol. The tests that are described below were performed:

1. Uterus growth test in infantile rats, p.o. (test for antiestrogenic action)
2. Tumor test: Antitumor action on the hormone-dependent breast cancer
DMBA⁺-induced breast cancer in rats
+ - dimethylbenzanthracene
1. Uterus growth test in infantile rats
(Antiestrogenic action)

Principle of the Method

In rodents, the uterus reacts to the administration of estrogens with a weight increase (both proliferation and water retention). This growth can be inhibited, depending on the dose, by simultaneous administration of compounds that have an antiestrogenic action.

Execution of the Test

Animals:

Infantile, female rats that weigh 35-45 g at the beginning of the test, 5-6 animals per dose.

Formulation and Administration of the Substances:

For p.o. administration, the substances are dissolved in 1 part ethanol (E) and made up with 9 parts peanut oil (EÖ).

Test Preparation

The young rats just dropped by the mothers are delivered for acclimation one day before the beginning of treatment and immediately supplied with food -- right in the cage. The treatment then is carried out once daily over 3 days in combination with 0.5 μ g of estradiolbenzoate (EB). EB is always administered subcutaneously (s.c.), while the test substance is administered p.o. (perorally). Twenty-four hours after the last administration, the animals are weighed, sacrificed, and the uteri are removed. The moist weights (less contents) are determined from the prepared uteri.

Controls

Negative control: vehicle (E/EÖ), 0.2 ml/animal/day

Positive control: 0.5 µg of EB/0.1 ml/animal/day

Evaluation

From the relative organ weights (mg/100 g of body weight), the average values with standard deviation (X + SD), and the significance of the differences to control group (EB) in the Dunnett test ($p < 0.05$) are determined for each group. The calculation of inhibition (in %) compared to the EB control is carried out with a program. The relative actions of the test substances are determined by co-variance and regression analysis.

Antiuterotrophic Action on Rats

Compound of Example	0.1 mg/kg p.o. % Inhibition	IC ₅₀
12	91	0.01
15	33	0.24
18	16	>0.30
29	80	0.01
31	71	0.04
36	62	0.03
Reference ZM 182 780	8	0.39

These results demonstrate the much higher antiestrogenic action of the compounds of general formula I compared to compound 7α-[9-(4,4,5,5,5-pentafluoropentylsulfinyl)-n-nonyl]-estra-

1,3,5(10)-triene-3,17 β -diol in each case after oral administration.

The compounds according to the invention are distinguished by a better bio-availability after oral administration.

2. Tumor Test

**Influencing the Tumor Growth in the DMBA* Model in Rats
(DMBA Tumor Model)**

*9,10-Dimethyl-1,2-benzanthracene

Biological Basis

The growth of the DMBA-induced breast neoplasm in rats is largely dependent on estrogens and prolactin. Active antiestrogens, antigestagens and aromatase inhibitors result in inhibiting tumor growth. Substances that have antigonadotrophic and androgenic properties also exert a tumor-inhibiting action.

Animal Subjects

45-47-day-old female rats (Sprague-Dawley, ZIH or Møllegard strains), 8-10 animals per group.

Test Preparation

The animals receive 10 mg of DMBA orally on a one-time basis. Then, the animals are checked once a week by palpation for tumor development. Six to ten weeks after the DMBA treatment, about 1 to 10 tumors develop per animal. The tumor size is determined once weekly with the aid of a sliding gauge.

If at least one tumor has reached a defined size (150 mm² of tumor surface area), the ovariectomy of the animals is carried out or the treatment of the animals with the test substance begins. In most cases, the treatment is carried out daily over about 28 days (for details of the procedure, see Test Plan). In addition, the tumor size is determined once a week.

Evaluation

The total tumor size per animal is determined before the beginning of the treatment (previous values). For each group, the mean of the percentage changes in tumor size, relative to the starting values, is then calculated. In addition, the percentage of animals per group is determined whose tumors in each case (1) have totally regressed (total regression), have partially regressed (partial regression), (3) are unchanged (no change) or (4) have further progressed (increase).

The values that are determined are tested for significance in the Dunnett Test and are depicted graphically.

Test Result

At an oral dose of 3 mg/kg/day, 11 β -fluoro-7 α -{5-[2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol (compound of Example 29) inhibits the tumor growth more greatly than an oral dose of 10 mg/kg/day of 7 α -[9-(4,4,5,5,5-pentafluoropentanesulfinyl)-nonyl]-estra-1,3,5(10)-triene-3,17 β -diol, which at this dose exerts only

a slight action in comparison to the intact control. An ovariectomy results in a total remission of tumors (Figure 1).

The compounds have an inhibiting action on the growth of hormone-dependent tumor cells; they especially inhibit the growth of estrogen-dependent human breast neoplasm cells (MCF-7).

The antiproliferative activity of the new compounds in breast neoplasm cell lines is greater than that of 7α -[9-4,4,5,5,5-pentafluoropentylsulfinyl]-n-nonyl]-estra-1,3,5(10)-triene-3,17 β -diol.

As pure antiestrogens for the purposes of this invention, those compounds of general formula I can be considered that show no agonistic action or only a slight agonistic action in the in-vitro test on estrogenic action below (up to about 10% of the action of estradiol).

In this case, the partial estrogenic action was also determined by transactivation assays. HeLa cells were transfected with human estrogen receptor-expression vector (HEGO) and a reporter gene rPR-TK-CAT. This reporter gene contains the "estrogen responsive element" of the rabbit progesterone receptor gene (+698/+729 region) before a TK-CAT gene (Savouret, J. F.; Bailly, A.; Misrahi, M.; Rauch, C.; Redeuilh, G.; Chauchereau, A.; Milgrom, E.: Characterization of the Hormone Responsive Element that is Involved in the Regulation of the Progesterone Receptor Gene. EMBO J. 10, 1875-1883 (1991).

The estrogenic active strength was determined at a concentration of 1 μ M.

Compound of Example	Activation of the rPR-TK Promoter [% Estradiol]*
12	-11
15	-25
18	-24
25	-21
29	10
31	-5
36	-6
Reference ZM 182780	-15

*A negative value means suppression of the reporter gene activity below the values of the controls.

The compounds according to the invention, especially if they are pure antiestrogens, are suitable for treatment of estrogen-dependent diseases, for example, breast cancer (second-line treatment of tamoxifen-resistant breast cancer; for adjuvant treatment of the breast cancer instead of tamoxifen), endometrial carcinoma, prostatic hyperplasia, anovulatory infertility and melanoma.

In addition, the pure antiestrogens of general formula I can be used as components in the products that are described in EP 346 014 B1 and that contain an estrogen and a pure antiestrogen,

namely for simultaneous, sequential or separate use for the selective estrogen therapy of peri- or postmenopausal women. The compounds of general formula I, especially if these are pure antiestrogens, can be used together with antigestagens (competitive progesterone antagonists) for the treatment of hormone-dependent tumors (EP 310 542 A).

Other indications, in which the compounds of the general formula can be used, are male hair loss, diffuse alopecia, alopecia that is caused by chemotherapy and hirsutism (Hye-Sun Oh and Robert C. Smart. Proc. Natl. Acad. Sci. USA, 93 (1996) 12525-12530).

In addition, the compounds of general formula I can be used for the production of medications for the treatment of endometriosis and endometrial carcinomas.

The compounds of general formula I can also be used for the production of pharmaceutical compositions for male and female birth control (male birth control: DE-A 195 10 862.0).

The compounds of general formula I with tissue-selective partial estrogenic action primarily can be used for prophylaxis and treatment of osteoporosis and for the production of preparations for substitution therapy in pre-, peri- and post-menopause (HRT) (Black, L. J.; Sato, M.; Rowley, E. R.; Magee, D. E.; Bekele, A.; Williams, D. C.; Cullinan, G. J.; Bendele, R.; Kauffman, R. F.; Bensch, W. R.; Frolik, C. A.; Termine, J. D. and Bryant, H. U.: Raloxifene [LY 139481 HCl] Prevents Bone Loss and Reduces Serum Cholesterol without Causing Uterine Hypertrophy in Ovariectomized Rats; J. Clin. Invest. 93: 63-69, 1994). The

partial estrogenic action occurs only on the desired target organ.

The invention also relates to pharmaceutical preparations that contain at least one compound of general formula I (or physiologically compatible addition salts with organic and inorganic acids of them), and the use of these compounds for the production of pharmaceutical agents, especially for treating estrogen-dependent diseases and tumors and pharmaceutical agents for hormone replacement treatment (HRT).

The compounds according to the invention and the acid addition salts are suitable for the production of pharmaceutical compositions and preparations. The pharmaceutical compositions or pharmaceutical agents contain as active ingredient one or more of the compounds according to the invention or their acid addition salts, optionally in a mixture with other pharmacologically or pharmaceutically active substances. The production of the pharmaceutical agents is carried out in a known way, whereby the known and commonly used pharmaceutical adjuvants as well as other commonly used vehicles and diluents can be used.

As such vehicles and adjuvants, for example, those are suitable which are recommended or indicated in the following bibliographic references as adjuvants for pharmaceuticals, cosmetics and related fields: Ullmans Encyklopädie der technischen Chemie [Ullman's Encyclopedia of Technical Chemistry], Volume 4 (1953), pp. 1 to 39; Journal of Pharmaceutical Sciences, Volume 52 (1963), pp. 918 and ff.; H. v. Czetsch-Lindenwald, Hilfsstoffe für Pharmazie und angrenzende

Gebiete [Adjuvants for Pharmaceutics and Related Fields]; Pharm. Ind. Number 2, 1961, pp. 72 and ff.; Dr. H. P. Fiedler, Lexikon der Hilfsstoffe für Pharmazie, Kosmetik und angrenzende Gebiete [Encyclopedia of Adjuvants for Pharmaceutics, Cosmetics and Related Fields], Cantor KG. Aulendorf in Württemberg 1971.

The compounds can be administered orally or parenterally, for example, intraperitoneally, intramuscularly, subcutaneously or percutaneously. The compounds can also be implanted in tissue. The amount of the compounds to be administered varies within a wide range and can cover any effective amount. Depending on the condition to be treated and the type of administration, the amount of administered compound is 0.1-25 mg/kg of body weight, preferably 0.5-5 mg/kg of body weight, per day. In humans, this corresponds to a daily dose of 5 to 1250 mg.

The preferred daily dosage in humans is 50 to 200 mg. This holds true especially for tumor therapy.

For oral administration, capsules, pills, tablets, coated tablets, etc., are suitable. In addition to the active ingredient, the dosage units can contain a pharmaceutically compatible vehicle, such as, for example, starch, sugar, sorbitol, gelatin, lubricant, silicic acid, talc, etc. The individual dosage units for oral administration can contain, for example, 5 to 500 mg of active ingredient.

To achieve a better bio-availability of the active ingredient, the compounds can also be formulated as cyclodextrin

clathrates. In this connection, the compounds with α -, β - or γ -cyclodextrin or their derivatives are reacted (PCT/EP95/02656).

For parenteral administration, the active ingredients can be dissolved or suspended in a physiologically compatible diluent. As a diluent, very frequently oils with or without the addition of a solubilizer, a surfactant, a suspending agent or emulsifier are used. Examples of oils that are used are olive oil, peanut oil, cottonseed oil, soybean oil, castor oil and sesame oil.

The compounds can also be used in the form of a depot injection or an implant preparation, which can be formulated so that a delayed release of active ingredient is made possible.

Implants can contain, as inert materials, for example, biodegradable polymers or synthetic silicones, such as, for example, silicone rubber. In addition, the active ingredients can be added to, for example, a patch, for percutaneous administration.

The compounds according to the invention can be produced as described below. The following examples are used for a more detailed explanation of the invention. By an analogous approach using reagents like those in the data that are contained in the examples, all compounds of general formula I can be obtained. The saponification of the ester groupings as well as esterification and etherification of free hydrogen groups is carried out in each case according to established processes of organic chemistry. By observing the differing reactivity of the esterified and free 3- and 17-hydroxy groups, the 3,17-diester can be cleaved selectively in 3-position, and the 3-hydroxy-17-

acyloxy compound can then be additionally functionalized specifically in the 3-position; it is equally possible to esterify or to etherify the 3,17-dihydroxy compound selectively only in the 3-position and then to introduce specifically another radical into the 17-position as already in the 3-position.

The acid addition salts of the compounds of general formula I can also be produced according to standard processes from the compounds of general formula I.

The examples below are used for a more detailed explanation of the invention:

Example 1

14,17-Ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 7 α -(5-tert-Butyldimethylsilyloxypentyl)-estr-4-ene-3,17-dione

In 70 ml of absolute tetrahydrofuran, 15.1 g of Mg chips with 175.6 g of 1-bromo-5-tert-butyl-dimethylsilyloxypentane [Tetrahedron Letters 23, 1982, 40, 4147-4150], dissolved in 600 ml of absolute tetrahydrofuran, are reacted to form the Grignard reagent. 59 g of copper(I) iodide is added to this solution, cooled to -20°C, under a nitrogen stream, and then 50 g of estr-4,6-diene-3,17-dione [Steroids Vol. 1, 1963, 233-249], dissolved in 300 ml of absolute THF, is added in drops within one hour. For working-up, 37.5 ml of acetic acid is added in drops, the reaction mixture is diluted with ethyl acetate, washed with saturated ammonium chloride solution, water and sodium bicarbonate solution and dried. The residue that is obtained after the concentration by evaporation is chromatographed on silica gel. 35.4 g of 7 α -(5-tert-butyldimethylsilyloxypentyl)-estr-4-ene-3,17-dione is obtained. $[\alpha]_D^{22} = +52.8^\circ$ (c = 0.535% in chloroform)

b) 7 α -(5-Hydroxypentyl)-estr-4-ene-3,17-dione

A solution of 125.4 g of 7 α -(5-*tert*-butyldimethylsilyloxypentyl)-estr-4-ene-3,17-dione in 625 ml of methanol and 347 ml of water is stirred with 694 ml of glacial acetic acid for 2.5 hours at 50°C. After the concentration by evaporation at 60°C in a vacuum, 94.1 g of crude 7 α -(5-hydroxypentyl)-estr-4-ene-3,17-dione is obtained as an oil.

c) 7 α -(5-Acetoxypentyl)-estr-4-ene-3,17-dione

A solution of 94 g of crude 7 α -(5-hydroxypentyl)-estr-4-ene-3,17-dione in 620 ml of pyridine is slowly mixed with 310 ml of acetic anhydride and stirred for 2 hours at 25°C. Then, it is slowly mixed with 116 ml of water while being cooled with ice, diluted with 3 l of diethyl ether, the organic phase is dried and concentrated by evaporation after washing with sodium bicarbonate solution. The residue is chromatographed on silica gel, and 84.4 g of 7 α -(5-acetoxypentyl)-estr-4-ene-3,17-dione is obtained as an oil.

d) 7 α -(5-Acetoxypentyl)-3-hydroxy-estra-1,3,5(10)-trien-17-one

17.8 g of lithium bromide and 92.83 g of copper(II) bromide are added to a solution of 82.3 g of 7 α -(5-acetoxypentyl)-estr-4-ene-3,17-dione in 936 ml of acetonitrile at a bath temperature of 80°C. After 10 minutes at a bath temperature of 80°C, the reaction solution is cooled, extracted three times with ethyl acetate, washed with water and sodium bicarbonate solution and dried. The residue that is obtained after the concentration by

evaporation is chromatographed on silica gel, and 60.4 g of 7 α -(5-acetoxypentyl)-3-hydroxy-estra-1,3,5(10)-trien-17-one is obtained as an oil.

e) 3-Acetoxy-7 α -(5-acetoxypentyl)-estra-1,3,5(10)-trien-10-one

A solution of 60.4 g of 7 α -(5-acetoxypentyl)-3-hydroxy-estra-1,3,5(10)-trien-17-one in 300 ml of pyridine is stirred with 150 ml of acetic anhydride for 1 hour at room temperature. Then, it is precipitated with a mixture of ice/water/common salt/hydrochloric acid, taken up with ethyl acetate, washed neutral with sodium bicarbonate and common salt solution, and dried on sodium sulfate and concentrated by evaporation in a vacuum. 63.9 g of 3-acetoxy-7 α -(5-acetoxypentyl)-estra-1,3,5(10)-trien-17-one is obtained as an oil.

f) 3-Acetoxy-7 α -(5-acetoxypentyl)-17,17-ethylenedioxy-estra-1,3,5(10)-triene

A solution of 63.9 g of 3-acetoxy-7 α -(5-acetoxypentyl)-estra-1,3,5(10)-trien-17-one in 460 ml of dichloromethane is stirred with 460 ml of ethylene glycol, 155 ml of trimethyl orthoformate and 1.2 g of *para*-toluenesulfonic acid for 3 hours at a bath temperature of 50°C. Then, it is diluted with dichloromethane, washed with sodium bicarbonate and common salt solution and dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/ethyl acetate. 63.2 g of 3-acetoxy-7 α -(5-acetoxypentyl)-17,17-ethylenedioxy-estra-1,3,5(10)-triene is obtained as an oil.

g) 3-Acetoxy-7 α -(5-acetoxypentyl)-16 α -bromo-17,17-ethylenedioxy-estra-1,3,5(10)-triene

A solution of 63.2 g of 3-acetoxy-7 α -(5-acetoxypentyl)-17,17-ethylenedioxy-estra-1,3,5(10)-triene in 630 ml of tetrahydrofuran is mixed in portions at 0°C with 61.7 g of pyridine hydrobromide perbromide, and it is stirred for 2 hours at 0°C. Then, a solution of 15 g of sodium sulfide in 70 ml of water is added, diluted with ethyl acetate, washed with sodium bicarbonate and common salt solution and dried on sodium sulfate and concentrated by evaporation in a vacuum. 74.1 g of 3-acetoxy-7 α -(5-acetoxypentyl)-16 α -bromo-17,17-ethylenedioxy-estra-1,3,5(10)-triene is obtained as an oil.

h) 17,17-Ethylenedioxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-3-ol

A solution of 74.1 g of 3-acetoxy-7 α -(5-acetoxypentyl)-16 α -bromo-17,17-ethylenedioxy-estra-1,3,5(10)-triene in 740 ml of dimethyl sulfoxide and 74 ml of methanol is stirred with 74 g of potassium hydroxide for 7.5 hours at a bath temperature of 85°C. Then, it is precipitated with ice/water/common salt, taken up with ethyl acetate, washed neutral, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/ethyl acetate. 36.12 g of pure 17,17-ethylenedioxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-3-ol is obtained as a foam.

i) 3-Hydroxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one

A solution of 36.12 g of 17,17-ethylenedioxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-3-ol in 958 ml of acetone and 111 ml of water is stirred for 2 hours at room temperature with 2.76 g of *para*-toluenesulfonic acid. Then, it is concentrated by evaporation in a vacuum to 1/3 of the volume, taken up with ethyl acetate, washed neutral, dried on sodium sulfate and concentrated by evaporation in a vacuum. 31.7 g of 3-hydroxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one is obtained as crystals with a melting point of 194-196°C.

j) 3,17-Diacetoxy-7 α -(5-acetoxypentyl)-estra-1,3,5(10),14,16-pentaene

A solution of 15.7 g of 3-hydroxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one in 330 ml of acetic anhydride is stirred with 4.6 g of *para*-toluenesulfonic acid for 4 hours at room temperature. Then, it is precipitated with pyridine/water/common salt, taken up in ethyl acetate, washed with sodium bicarbonate and common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/ethyl acetate. 11.1 g of pure 3,17-diacetoxy-7 α -(5-acetoxypentyl)-estra-1,3,5(10),14,16-pentaene is obtained as an oil.

k) 3,17 β -Diacetoxy-7 α -(5-acetoxypentyl)-14 α ,17 α -etheno-estra-1,3,5(10)-triene

11.0 g of 3,17-diacetoxy-7 α -(5-acetoxypentyl)-estra-1,3,5(10),14,16-pentaene in 120 ml of benzene is treated at 300 bar and 175°C for 6.5 days with ethene. Then, it is taken up in ethyl acetate, washed with sodium bicarbonate and common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/ethyl acetate. 8.4 g of 3,17 β -diacetoxy-7 α -(5-acetoxypentyl)-14 α ,17 α -etheno-estra-1,3,5(10)-triene is obtained as a foam.

l) 3,17 β -Diacetoxy-7 α -(5-acetoxypentyl)-14 α ,17 α -ethano-estra-1,3,5(10)-triene

A solution of 8.4 g of 3,17 β -diacetoxy-7 α -(5-acetoxypentyl)-14 α ,17 α -etheno-estra-1,3,5(10)-triene in 200 ml of ethyl acetate is shaken with 1.5 g of palladium (10%) on carbon for one hour at room temperature with hydrogen. Then, it is suctioned off on Celite, rewashed with ethyl acetate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/ethyl acetate. 6.0 g of 3,17 β -diacetoxy-7 α -(5-acetoxypentyl)-14 α ,17 α -ethano-estra-1,3,5(10)-triene is obtained as a foam.

m) 14 α ,17 α -Ethano-7 α -(5-hydroxypentyl)-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 6.0 g of 3,17 β -diacetoxy-7 α -(5-acetoxypentyl)-14 α ,17 α -ethano-estra-1,3,5(10)-triene in 100 ml of a 1-molar potassium hydroxide solution is allowed to stand for 7.5 hours at

room temperature. Then, it is added to 1-molar hydrochloric acid, extracted three times with ethyl acetate, washed with sodium bicarbonate and common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and recrystallized from acetone/hexane. 4.57 g of $14\alpha,17\alpha$ -ethano- 7α -(5-hydroxypentyl)-estra-1,3,5(10)-triene-3,17 β -diol is obtained as colorless crystals with a melting point of 63-65°C.

n) 3-Benzylloxy- $14\alpha,17\alpha$ -ethano- 7α -(5-hydroxypentyl)-estra-1,3,5(10)-trien-17 β -ol

A solution of 4.5 g of $14\alpha,17\alpha$ -ethano- 7α -(5-hydroxypentyl)-estra-1,3,5(10)-triene-3,17 β -diol in 90 ml of acetonitrile is stirred with 1.91 g of potassium carbonate and 1.53 ml of benzyl bromide for 6.5 hours at a bath temperature of 80°C. Then, it is concentrated by evaporation in a vacuum to 1/3 of the volume, added to water, extracted three times with ethyl acetate, washed neutral, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/acetone. 4.8 g of 3-benzylloxy- $14\alpha,17\alpha$ -ethano- 7α -(5-hydroxypentyl)-estra-1,3,5(10)-trien-17 β -ol is obtained as a foam.

o) 3-Benzylloxy- $14\alpha,17\alpha$ -ethano- 7α -(5-tosyloxypentyl)-estra-1,3,5(10)-trien-17 β -ol

A solution of 4.8 g of 3-benzylloxy- $14\alpha,17\alpha$ -ethano- 7α -(5-hydroxypentyl)-estra-1,3,5(10)-trien-17 β -ol in 50 ml of pyridine is stirred at 0°C with 3.63 g of toluenesulfonic acid anhydride

for 4 hours. Then, it is diluted with ethyl acetate, extracted with 2-molar hydrochloric acid, washed neutral, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/ethyl acetate. 4.75 g of 3-benzyloxy-14 α ,17 α -ethano-7 α -(5-tosyloxypentyl)-estra-1,3,5(10)-trien-17 β -ol is obtained as a foam.

p) 3-Benzyloxy-14 α ,17 α -ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17 β -ol

A solution of 4.7 g of 3-benzyloxy-14 α ,17 α -ethano-7 α -(5-tosyloxypentyl)-estra-1,3,5(10)-trien-17 β -ol in 100 ml of dimethylformamide is stirred with 2.7 g of methyl-[3-(4,4,5,5,5-pentafluoropentylthio)-propyl]-amine for 4 hours at a bath temperature of 80°C. Then, it is added to water, extracted three times with ethyl acetate, washed with common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 3.8 g of 3-benzyloxy-14 α ,17 α -ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17 β -ol is obtained as an oil.

q) 14 α ,17 α -Ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 3.7 g of 3-benzyloxy-14 α ,17 α -ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-

pentyl}-estra-1,3,5(10)-trien-17 β -ol in 65 ml of dichloromethane is stirred at 0°C with 2.1 ml of N,N-dimethylaniline for 5 minutes, mixed with 2.75 g of anhydrous aluminum chloride and stirred for 3.5 hours at 0°C. Then, it is mixed with saturated, aqueous potassium sodium tartrate solution, added to water, extracted three times with dichloromethane, washed neutral, dried on sodium sulfate and concentrated by evaporation in a vacuum. 6.3 g of crude product, which is chromatographed on silica gel with dichloromethane/methanol, is obtained. 2.85 g of pure 14 α ,17 α -ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as crystals with a melting point of 63-67°C, $[\alpha]_D^{22} = +19.4^\circ$ (c = 0.505% in chloroform).

Example 2

14,17-Ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 1.0 g of 14 α ,17 α -ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol in 37.5 ml of methanol and 1.78 ml of water is stirred with 381 mg of sodium periodate for 5 hours at room temperature. Then, it is added to water, extracted three times with dichloromethane, washed neutral, dried on sodium sulfate and concentrated by evaporation in a vacuum. 985 mg of crude product, which is chromatographed on silica gel with dichloromethane/methanol, is obtained. 514.3 mg of pure 14,17-

ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentane-sulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as crystals with a melting point of 84-86°C; $[\alpha]_D^{22} = +13.0^\circ$ (c = 0.5% in chloroform).

Example 3

3,17 β -Diacetoxy-14 α ,17 α -ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene

A solution of 600 mg of 14 α ,17 α -ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol in 2 ml of pyridine and 1 ml of acetic anhydride is stirred with 5 mg of dimethylaminopyridine for 4.5 hours at room temperature. Then, it is diluted with ethyl acetate, washed with water and common salt solution, dried on sodium sulfate and concentrated by evaporation in a vacuum. 680 mg of 3,17 β -diacetoxy-14 α ,17 α -ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene is obtained as an oil.

Example 4

14,17-Ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 650 mg of 3,17 β -diacetoxy-14 α ,17 α -ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene in 15 ml of glacial acetic acid is

stirred with 1.5 g of sodium perborate tetrahydrate for 3 hours at room temperature. Then, it is added to water, extracted three times with dichloromethane, washed neutral, dried on sodium sulfate, concentrated by evaporation in a vacuum, taken up in 10 ml of 0.2-molar methanolic potassium hydroxide solution, stirred for 24 hours at room temperature, added to water, extracted three times with dichloromethane, washed neutral, dried on sodium sulfate, concentrated by evaporation in a vacuum, suspended in 20 ml of ethyl acetate, mixed with 10 ml of tin(II) chloride solution, stirred for 4 hours at room temperature, diluted with ethyl acetate, washed with common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/ethyl acetate. 300 mg of pure 14,17-ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as crystals with a melting point of 55-58°C; $[\alpha]_D^{22} = +19.4^\circ$ (c = 0.51% in chloroform).

Example 5

17 α -Trifluoromethyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 17 β -Acetoxy-7 α -(5-tert-butyl-dimethylsilyloxypentyl)-estr-4-en-3-one

In 200 ml of absolute THF, 22.9 g of Mg chips with 261 g of 1-bromo-5-tert-butyl-dimethylsilyloxypentane [Tetrahedron Letters 23, 1982, 40, 4147-4150], dissolved in 250 ml of absolute THF is

reacted to form the Grignard reagent. 92.9 g of copper(I) iodide is added to this solution, cooled to -20°C under a nitrogen stream, and then 73.5 g of 17β -acetoxyestra-4,6-dien-3-one [J. Am. Chem. Soc. 80, 1958, 2596-2597], dissolved in 300 ml of absolute THF, is added in drops within one hour. For working-up, 61.2 ml of acetic acid is added in drops, the reaction mixture is diluted with ethyl acetate, washed with saturated ammonium chloride solution, water and sodium bicarbonate solution and dried. The residue that is obtained after the concentration by evaporation is chromatographed on silica gel. 48 g of 17β -acetoxy- 7α -(5-*tert*-butyl-dimethylsilyloxypentyl)-estr-4-en-3-one is obtained.

b) 17β -Acetoxy- 7α -(5-hydroxypentyl)-estr-4-en-3-one

A solution of 48 g of 17β -acetoxy- 7α -(5-*tert*-butyl-dimethylsilyloxypentyl)-estr-4-en-3-one in 350 ml of methanol is allowed to stand with 35 ml of 8 vol% sulfuric acid for 30 minutes at room temperature. The solution is diluted with diethyl ether, washed neutral with water, and dried. After the concentration by evaporation, 37.7 g of 17β -acetoxy- 7α -(5-hydroxypentyl)-estr-4-en-3-one is obtained as an oil.

c) 17β -Acetoxy- 7α -(5-acetoxypentyl)-estr-4-en-3-one

A solution of 37.7 g of 17β -acetoxy- 7α -(5-hydroxypentyl)-estr-4-en-3-one in 160 ml of pyridine is slowly mixed with 80 ml of acetic anhydride and stirred for 16 hours at 25°C . Then, it is diluted with ethyl acetate, and the organic phase, after

washing with sodium bicarbonate solution, is dried and concentrated by evaporation. The residue is chromatographed on silica gel, and 26.6 g of 17 β -acetoxy-7 α -(5-acetoxypentyl)-estr-4-en-3-one is obtained as an oil. $[\alpha]_D^{22} = +20.0^\circ$ (c = 0.51% in chloroform)

d) 17 β -Acetoxy-7 α -(5-acetoxypentyl)-estra-1,3,5(10)-trien-3-ol

A solution of 5.18 g of lithium bromide and 26.73 g of copper(II) bromide in 260 ml of acetonitrile is added in drops to a solution, heated to 80°C, of 26.6 g of 17 β -acetoxy-7 α -(5-acetoxypentyl)-estr-4-en-3-one in 260 ml of acetonitrile within 30 minutes while being stirred. After the addition is completed, the reaction solution is cooled, diluted with diethyl ether, washed with water and sodium bicarbonate solution and dried. The residue that is obtained after the concentration by evaporation is chromatographed on silica gel, and 21.3 g of 17 β -acetoxy-7 α -(5-acetoxypentyl)-1,3,5(10)-estratrien-3-ol is obtained as an oil. $[\alpha]_D^{22} = +28.9^\circ$ (c = 0.535% in chloroform)

e) 17 β -Acetoxy-7 α -(5-acetoxypentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene

A solution of 21.3 g of 17 β -acetoxy-7 α -(5-acetoxypentyl)-estra-1,3,5(10)-trien-3-ol in 213 ml of tetrahydrofuran is allowed to stand with 21.3 ml of 3,4-dihydro-2H-pyran and 1.065 g of p-toluenesulfonic acid for 8 hours at room temperature. The reaction solution is mixed with 3 ml of pyridine, then diluted with diethyl ether, washed with water and dried. The residue

that is obtained after the concentration by evaporation is chromatographed on silica gel, and 24.3 g of 17 β -acetoxy-7 α -(5-acetoxypentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene is obtained as an oil. $[\alpha]_D^{22} = +31.5^\circ$ (c = 0.535% in chloroform)

f) 17 β -Acetoxy-7 α -(5-hydroxypentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene

A solution of 10.2 g of 17 β -acetoxy-7 α -(5-acetoxypentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene in 205 ml of methanol is stirred with 33.7 ml of sodium hydroxide solution for 45 minutes at 15°C. Then, it is diluted with diethyl ether, washed with water, dried on sodium sulfate and concentrated by evaporation in a vacuum. 5.6 g of 17 β -acetoxy-7 α -(5-hydroxypentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene is obtained. $[\alpha]_D^{22} = +32.2^\circ$ (c = 0.505% in chloroform)

g) 17 β -Acetoxy-3-(tetrahydropyran-2-yloxy)-7 α -(5-p-toluenesulfonyloxypentyl)-estra-1,3,5(10)-triene

A solution of 5.5 g of 17 β -acetoxy-7 α -(5-hydroxypentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene in 47 ml of pyridine is allowed to stand with 5.5 g of p-toluenesulfonic acid anhydride for 45 minutes at room temperature. Then, the reaction solution is cooled in an ice bath, mixed with 4 ml of water and stirred for 45 more minutes. It is then diluted with ethyl acetate, washed with water, dried and concentrated by evaporation. 8.2 g of 17 β -acetoxy-3-(tetrahydropyran-2-yloxy)-

7 α -(5-p-toluenesulfonyloxypentyl)-estra-1,3,5(10)-triene is obtained as an oil.

h) 17 β -Acetoxy-7 α -(5-methylaminopentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene

6.3 g of methylamine is condensed in a pressure pipe while being cooled with ice in a solution of 8.2 g of 17 β -acetoxy-3-(tetrahydropyran-2-yloxy)-7 α -(5-p-toluenesulfonyloxypentyl)-estra-1,3,5(10)-triene in 80 ml of tetrahydrofuran. The closed pressure pipe is then heated for 6 hours to 60°C. After cooling, it is evaporated to the dry state in a vacuum, and the residue is chromatographed on silica gel. 5.1 g of 17 β -acetoxy-7 α -(5-methylaminopentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene is obtained as an oil. $[\alpha]_D^{22} = +29.7^\circ$ (c = 0.535% in chloroform)

i) 17 β -Acetoxy-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene

A solution of 1.64 g of 17 β -acetoxy-7 α -(5-methylaminopentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene in 25 ml of absolute DMF is stirred with 159 mg of 80% sodium hydride under nitrogen for 2 hours at room temperature. 1.43 g of 3-chloropropyl-4,4,5,5,5-pentafluoropentylsulfide in 7 ml of absolute DMF is then added in drops and then stirred for 22 more hours at 80°C. The reaction solution is then diluted with ethyl acetate, washed with water, dried, concentrated by

evaporation, and the residue is chromatographed on silica gel.

820 mg of 17 β -acetoxy-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene is obtained as an oil.

$$[\alpha]_D^{22} = +21.5^\circ \text{ (c = 0.51\% in chloroform)}$$

j) 7 α -{5-[N-Methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17 β -ol

A solution of 790 mg of 17 β -acetoxy-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-triene in 8 ml of methanol and 3 ml of THF is stirred with 430 mg of potassium carbonate for 18 hours at room temperature. The reaction solution is diluted with diethyl ether, washed with water, dried and concentrated by evaporation. 750 mg of crude 7 α -{5-N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17 β -ol is obtained.

k) 7 α -{5-[N-Methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 750 mg of 7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17 β -ol in 28 ml of methanol and 2.8 ml of water is stirred with 350 mg of oxalic acid for 17 hours at room temperature. It is then diluted with ethyl

acetate, washed with sodium bicarbonate solution and water, dried and concentrated by evaporation. The residue is chromatographed on silica gel, and 640 mg of 7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as an oil. $[\alpha]_D^{22} = +24.0^\circ$ (c = 0.515% in chloroform)

1) 7 α -{5-[N-Methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one

A solution of 900 mg of 7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17 β -ol is mixed in 30 ml of toluene and 9.6 ml of cyclohexanone with a solution of 900 mg of aluminum isopropylate in 16 ml of toluene and heated for 30 minutes while being distilled off slowly. The reaction solution is then diluted with ethyl acetate, washed with 20% potassium sodium tartrate solution, dried and concentrated by evaporation. The residue is chromatographed on silica gel with hexane/ethyl acetate. 715 mg of 7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one is obtained as an oil.

m) 17 α -Trifluoromethyl-3-(tetrahydropyran-2-yloxy)-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17 β -ol

A solution of 500 mg of 7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one (see Ausw.-Pat Example 2a) in 5 ml of absolute tetrahydrofuran is mixed at a bath temperature of 0°C with 0.27 ml of (trifluoromethyl)-trimethylsilane. Then, 0.2 ml of a 1.1-molar tetrabutylammonium fluoride solution is slowly added in drops and stirred for 45 minutes, again 1 ml of 1.1-molar tetrabutylammonium fluoride solution is added, and it is stirred for another 30 minutes. Then, it is diluted with ethyl acetate, washed with water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 285 mg of 17 α -trifluoromethyl-3-(tetrahydropyran-2-yloxy)-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17 β -ol is obtained as an oil.

n) 17 α -Trifluoromethyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 280 mg of 17 α -trifluoromethyl-3-(tetrahydropyran-2-yloxy)-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17 β -ol in 5.6 ml of methanol and 0.56 ml of water is stirred with 140 mg of oxalic acid for 18 hours at room

temperature. Then, it is diluted with ethyl acetate, washed with sodium bicarbonate and water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 215 mg of 17 α -trifluoromethyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as an oil.

Example 6

15 β ,16 β -Methano-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 3-Benzoyloxy-17,17-ethylenedioxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraene

A solution of 32.7 g of 17,17-ethylenedioxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-3-ol (see Example 1h) in 327 ml of dimethylformamide is mixed at room temperature with 5.73 g of lithium hydroxide and stirred with 15.1 ml of benzyl bromide for 2 hours at 60°C. Then, it is diluted with ethyl acetate, washed with water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 32.8 g of 3-benzoyloxy-17,17-ethylenedioxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraene is obtained.

b) 3-Benzylloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one

A solution of 32.8 g of 3-benzylloxy-17,17-ethylenedioxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraene in 328 ml of acetone and 32.8 ml of water is stirred at room temperature with 1.033 g of *para*-toluenesulfonic acid for 2 hours. Then, it is diluted with diethyl ether, washed with sodium bicarbonate and water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/acetone. 25.4 g of 3-benzylloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one is obtained.

c) 3-Benzylloxy-7 α -(5-hydroxypentyl)-15 β ,16 β -methano-estra-1,3,5(10),15-tetraen-17-one

2.861 g of trimethylsulfoxonium iodide with 345 mg of 80% sodium hydride is reacted in 65 ml of dimethylsulfoxide over a period of 2 hours at room temperature. 4.44 g of 3-benzylloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one is added to this solution, and it is stirred for 45 minutes at room temperature. The settled precipitate is filtered off, and it is washed with water. This precipitate is taken up with ethyl acetate, washed with water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/acetone. 2.8 g of 3-benzylloxy-7 α -(5-hydroxypentyl)-15 β ,16 β -methano-estra-1,3,5(10),15-tetraen-17-one is obtained.
 $[\alpha]_D^{22} = +13.1^\circ$ (c = 0.525% in chloroform).

d) 3-Benzylloxy-15 β ,16 β -methano-7 α -(5-tosyloxypropyl)-estra-1,3,5(10),15-tetraen-17-one

A solution of 2.5 g of 3-benzylloxy-7 α -(5-hydroxypropyl)-15 β ,16 β -methano-estra-1,3,5(10),15-tetraen-17-one in 25 ml of pyridine is mixed at room temperature with 2.5 g of *para*-toluenesulfonic acid anhydride and allowed to stand for 30 minutes, mixed with 1 ml of water while being cooled with ice and allowed to stand for another 45 minutes. Then, it is diluted with diethyl ether, washed with water, dried on sodium sulfate and concentrated by evaporation in a vacuum. 3.4 g of crude 3-benzylloxy-15 β ,16 β -methano-7 α -(5-tosyloxypropyl)-estra-1,3,5(10),15-tetraen-17-one is obtained.

e) 3-Benzylloxy-15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)propylamino]pentyl}-estra-1,3,5(10),15-tetraen-17-one

A solution of 2.1 g of methyl-[3-(4,4,5,5,5-pentafluoropentylthio)propyl]-amine in 1 ml of dimethylformamide is added to a solution of 3.4 g of crude 3-benzylloxy-15 β ,16 β -methano-7 α -(5-tosyloxypropyl)-estra-1,3,5(10),15-tetraen-17-one in 34 ml of dimethylformamide, and it is stirred for 3.5 hours at 100°C. Then, it is diluted with ethyl acetate, washed with water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 2.6 g of 3-benzylloxy-15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-

propylamino]-pentyl}-estra-1,3,5(10),15-tetraen-17-one is obtained as an oil.

f) 15 β ,16 β -Methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-hydroxy-estra-1,3,5(10),15-tetraen-17-one

A solution of 2.3 g of 3-benzyloxy-15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10),15-tetraen-17-one in 53 ml of dichloromethane is stirred at a bath temperature of 0°C with 1.12 ml of N,N-dimethylaniline and 1.64 g of aluminum chloride (anhydrous) for 4.5 hours. Then, it is diluted with ethyl acetate, washed with 30% potassium-sodium tartrate solution and water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 1.52 g of 15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-hydroxy-estra-1,3,5(10),15-tetraen-17-one is obtained as an oil. $[\alpha]_D^{22} = -2.5^\circ$ (c = 0.505% in chloroform).

g) 15 β ,16 β -Methano-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

1.8 ml of a 3-molar methylmagnesium bromide solution is added in drops to a solution of 515 mg of 15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-hydroxy-estra-1,3,5(10),15-tetraen-17-one in 10 ml of

tetrahydrofuran at a bath temperature of 0°C, and it is stirred for 2 hours at room temperature. Then, it is diluted with ethyl acetate, washed with saturated ammonium chloride solution and water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 395 mg of 15 β ,16 β -methano-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as an oil. $[\alpha]_D^{22} = -5.1^\circ$ (c = 0.52% in chloroform)

Example 7

15 β ,16 β -Methano-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 115 mg of 15 β ,16 β -methano-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol (see Example 6) in 5 ml of methanol is stirred with 80 mg of sodium periodate for 3 hours at room temperature. Then, it is diluted with ethyl acetate, washed with water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 65 mg of 15 β ,16 β -methano-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as an oil. $[\alpha]_D^{22} = -13.3^\circ$ (c = 0.27% in chloroform)

Example 8

15 β ,16 β -Methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 500 mg of 15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-3-hydroxy-estra-1,3,5(10),15-tetraen-17-one (see Example 6f) in 10 ml of methanol and 1 ml of water is stirred with 100 mg of sodium borohydride for 3 hours at room temperature. Then, it is diluted with ethyl acetate, washed with water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 340 mg of 15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as an oil. $[\alpha]_D^{22} = +11.9^\circ$ (c = 0.52% in chloroform)

Example 9

15 β ,16 β -Methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 100 mg of 15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol (see Example 8) in 5 ml of methanol is stirred with 80 mg of sodium periodate for 3 hours at room temperature. Then, it is diluted with ethyl acetate, washed with water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/

methanol. 70 mg of 15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as an oil. $[\alpha]_D^{22} = +12.2^\circ$ (c = 0.515% in chloroform).

Example 10

15 β -Methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 3-Benzoyloxy-7 α -(5-hydroxypentyl)-15 β -methyl-estra-1,3,5(10)-trien-17-one

5.35 g of copper(I) iodide is added to an ice-cooled solution of 11.9 ml of a 3-molar methylmagnesium bromide solution in 68 ml of tetrahydrofuran under a nitrogen stream. Then, a solution of 4.26 g of 3-benzoyloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one (see Example 6b) in 50 ml of tetrahydrofuran is added in drops and stirred for 30 minutes at a bath temperature of 0°C. Then, the excess reagent is decomposed with saturated ammonium chloride solution, diluted with ethyl acetate, washed with ammonium chloride solution and water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/acetone. 3.6 g of 3-benzoyloxy-7 α -(5-hydroxypentyl)-15 β -methyl-estra-1,3,5(10)-trien-17-one is obtained as an oil. $[\alpha]_D^{22} = +66.4^\circ$ (c = 0.515% in chloroform).

b) 3-Benzylloxy-15 β -methyl-7 α -(5-tosyloxypropyl)-estra-1,3,5(10)-trien-17-one

A solution of 3.6 g of 3-benzylloxy-7 α -(5-hydroxypropyl)-15 β -methyl-estra-1,3,5(10)-trien-17-one is tosylated as described in Example 6d. 4.9 g of crude 3-benzylloxy-15 β -methyl-7 α -(5-tosyloxypropyl)-estra-1,3,5(10)-trien-17-one is obtained.

c) 3-Benzylloxy-15 β -methyl-7 α -(5-N-methylaminopropyl)-estra-1,3,5(10)-trien-17-one

3.8 g of methylamine is condensed in a solution of 4.9 g of 3-benzylloxy-15 β -methyl-7 α -(5-tosyloxypropyl)-estra-1,3,5(10)-trien-17-one in 30 ml of tetrahydrofuran in a pressurized reactor while being cooled, the closed reactor is heated for 5.5 hours to 80°C, cooled and opened. Then, it is diluted with ethyl acetate, washed with water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol/1% triethylamine. 3.15 g of 3-benzylloxy-15 β -methyl-7 α -(5-N-methylaminopropyl)-estra-1,3,5(10)-trien-17-one is obtained as an oil.

d) 3-Benzylloxy-15 β -methyl-7 α -(5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-propylthio)-propylamino]-propyl)-estra-1,3,5(10)-trien-17-one

A solution of 3.15 g of 3-benzylloxy-15 β -methyl-7 α -(5-N-methylaminopropyl)-estra-1,3,5(10)-trien-17-one in 31.5 ml of absolute dimethylformamide is mixed with 228 mg of 80% sodium hydride and stirred for 5 hours at room temperature, mixed with

2.6 g of 3-chloropropyl-4,4,5,5,5-pentafluoropentylsulfide in 2 ml of absolute dimethylformamide and stirred for 24 hours at 80°C. Then, it is diluted with ethyl acetate, washed with sodium bicarbonate and water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 3.1 g of 3-benzyloxy-15 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10),15-trien-17-one is obtained as an oil.

e) 3-Hydroxy-15 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17-one

A solution of 3.1 g of 3-benzyloxy-15 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17-one is debenzylated as described in Example 6f. 830 mg of 3-hydroxy-15 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17-one is obtained as an oil.

f) 15 β -Methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 460 mg of 3-hydroxy-15 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17-one is reduced as described in Example 8. 200 mg of 15 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-

triene-3,17 β -diol is obtained as an oil. $[\alpha]_D^{22} = +4.5^\circ$ (c = 0.51% in chloroform)

Example 11

15 β ,17 α -Dimethyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

1.44 g of dried cerium(III) chloride is stirred for 2 hours at room temperature in 15 ml of tetrahydrofuran, mixed with 3.75 ml of a 3-molar methylmagnesium bromide solution while being cooled with ice, stirred for 15 minutes while being cooled and for 30 minutes at room temperature, a solution of 650 mg of 3-hydroxy-15 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17-one (see Example 10e) in 7 ml of tetrahydrofuran is added in drops, stirred for 2 hours at room temperature, and excess reagent is decomposed with saturated ammonium chloride solution. Then, it is diluted with ethyl acetate, washed with saturated ammonium chloride solution and water, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 145 mg of 15 β ,17 α -dimethyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as an oil. $[\alpha]_D^{22} = -7.3^\circ$ (c = 0.505% in chloroform).

Example 12.

11 β -Fluoro-7 α -(5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol

a) 11 β -Fluoro-estr-4-ene-3,17-dione

4.6 ml of perfluorobutane-1-sulfonic acid fluoride is added in drops to 5.0 g of 11 α -hydroxy-estr-4-ene-3,17-dione in 100 ml of toluene and 7.3 ml of 1,8-diazabicyclo[5,4,0]undec-7-ene at 0°C. After 30 minutes, the solution is diluted with ethyl acetate, washed with saturated sodium chloride solution, dried and concentrated by evaporation in a vacuum. After the crude product is chromatographed on silica gel with a hexane-ethyl acetate gradient, 3.8 g of 11 β -fluoro-estr-4-ene-3,17-dione with a melting point of 173-174°C is obtained.

b) 11 β -Fluoro-3-methoxy-estra-3,5-dien-17-one

7.8 g of 11 β -fluoro-estr-4-ene-3,17-dione is stirred in 40 ml of 2,2-dimethoxypropane with 780 mg of pyridinium-toluene-4-sulfonate for 5 hours at 80°C. Then, 1.5 ml of triethylamine is added, it is diluted with ethyl acetate and washed with saturated sodium chloride solution. After crystallization from methanol, 5.3 g of 11 β -fluoro-3-methoxy-estra-3,5-dien-17-one with a melting point of 173°C is obtained.

c) 11 β -Fluoro-estra-4,6-diene-3,17-dione

5 ml of a 10% sodium acetate solution and, in portions, 2.5 g of 1,3-dibromo-5,5-dimethylhydantoin are added in succession to 5.0 g of 11 β -fluoro-3-methoxy-estra-3,5-dien-17-one in 50 ml of

DMF at 0°C. After 30 minutes, 2.3 g of sodium sulfite is added and then 2.5 g of lithium bromide and 2.0 g of lithium carbonate, and it is stirred for 2 hours at 100°C. The reaction mixture is stirred into ice water. The precipitated product is suctioned off, dissolved in ethyl acetate, washed with water, dried and concentrated by evaporation in a vacuum. After recrystallization from ethyl acetate, 3.6 g of 11 β -fluoro-estra-4,6-diene-3,17-dione with a melting point of 198°C is obtained.

d) 11 β -Fluoro-7 α -(5-*tert*-butyl-dimethylsilyloxypentyl)-estr-4-ene-3,17-dione

7.9 g of magnesium in 40 ml of THF is reacted to form the Grignard reagent under nitrogen with a solution of 95.3 g of 1-bromo-5-*tert*-butyl-dimethylsilyloxypentane [Tetrahedron Letters 1982, 4147-4150] in 260 ml of THF. At -30°C, 32 g of copper(I) iodide is added, and then 29 g of 11 β -fluoro-estra-4,6-diene-3,17-dione in 290 ml of THF is added in drops. After the reaction is completed, it is mixed with 20.4 ml of glacial acetic acid, and the reaction mixture is stirred into ice water. The precipitated product is suctioned off, dissolved in ethyl acetate, washed neutral with water and dried. After the crude product is chromatographed on silica gel with a hexane-ethyl acetate gradient, 23.9 g of 11 β -fluoro-7 α -(5-*tert*-butyl-dimethylsilyloxypentyl)-estr-4-ene-3,17-dione is obtained as a foam.

e) 11 β -Fluoro-7 α -(5-hydroxypentyl)-estr-4-ene-3,17-dione

A solution of 23.1 g of 11 β -fluoro-7 α -(5-*tert*-butyldimethylsilyloxypentyl)-estr-4-ene-3,17-dione in 115 ml of THF and 64 ml of water are stirred with 128 ml of glacial acetic acid for 2.5 hours at 50°C. The reaction mixture is concentrated by evaporation in a vacuum, taken up in ethyl acetate, washed with water and dried. 20.4 g of 11 β -fluoro-7 α -(5-hydroxypentyl)-estr-4-ene-3,17-dione is obtained as a foam.

f) 7 α -(5-Acetoxypentyl)-11 β -fluoro-estr-4-ene-3,17-dione

20 g of 11 β -fluoro-7 α -(5-hydroxypentyl)-estr-4-ene-3,17-dione in 100 ml of pyridine can be reacted over a period of 2 hours with 50 ml of acetic anhydride at 25°C. Then, 5 ml of water is added at 0°C, and it is stirred for 45 minutes. It is extracted with diethyl ether, washed with 2N sulfuric acid, pyridine-free, and the solution is neutralized in succession with saturated sodium bicarbonate solution and water. After drying and concentration by evaporation in a vacuum, the crude product is chromatographed on silica gel with a hexane-ethyl acetate gradient. 17 g of 7 α -(5-acetoxypentyl)-11 β -fluoro-estr-4-ene-3,17-dione with a melting point of 78.4°C is obtained.

g) 7 α -(5-Acetoxypentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one

18.6 g of copper(II) bromide and 3.6 g of lithium bromide are added to 16.5 g of 7 α -(5-acetoxypentyl)-11 β -fluoro-estr-4-ene-3,17-dione in 190 ml of acetonitrile at 80°C. After 15 minutes,

the reaction mixture is stirred into sodium bicarbonate-containing ice water. The precipitated product is suctioned off, dissolved in ethyl acetate, washed with water, dried and concentrated by evaporation in a vacuum. After the crude product is chromatographed on silica gel with a hexane-ethyl acetate gradient, 8.5 g of 7 α -(5-acetoxypentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one is obtained as a foam.

h) 7 α -(5-Acetoxypentyl)-11 β -fluoro-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one

8.2 g of 7 α -(5-acetoxypentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one in 86 ml of THF is stirred with 8.6 ml of 3,4-dihydro-2H-pyran and 820 mg of p-toluenesulfonic acid hydrate for 2.5 hours at room temperature. Then, 0.5 ml of triethylamine is added, it is diluted with ethyl acetate, washed with saturated sodium chloride solution, dried and concentrated by evaporation in a vacuum. After the crude product is chromatographed on silica gel with a hexane-ethyl acetate gradient, 7.8 g of 7 α -(5-acetoxypentyl)-11 β -fluoro-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one is obtained as a foam.

i) 11 β -Fluoro-7 α -(5-hydroxypentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one

7.4 g of 7 α -(5-acetoxypentyl)-11 β -fluoro-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one in 370 ml of methanol and 37 ml of water is stirred at room temperature with 1.8 g of potassium carbonate. After 3 hours, the reaction mixture is

added to ice water. The precipitated product is suctioned off, dissolved in ethyl acetate, washed neutral with water, dried and concentrated by evaporation in a vacuum. 7.0 g of 11 β -fluoro-7 α -(5-hydroxypentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one is obtained as a foam.

j) 11 β -Fluoro-3-(tetrahydropyran-2-yloxy)-7 α -(5-p-toluenesulfonyloxypentyl)-estra-1,3,5(10)-trien-17-one

6.7 g of 11 β -fluoro-7 α -(5-hydroxypentyl)-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one in 70 ml of pyridine is stirred at room temperature with 6.0 g of p-toluenesulfonic acid anhydride for 3 hours. The solution is diluted with ethyl acetate, washed with saturated sodium chloride solution, dried and concentrated by evaporation in a vacuum. The crude product is chromatographed on silica gel with a hexane-ethyl acetate gradient. 5.7 g of 11 β -fluoro-3-(tetrahydropyran-2-yloxy)-7 α -(5-p-toluenesulfonyloxy-pentyl)-estra-1,3,5(10)-trien-17-one is obtained as a foam.

k) 11 β -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one

2.0 g of 11 β -fluoro-3-(tetrahydropyran-2-yloxy)-7 α -(5-p-toluenesulfonyloxypentyl)-estra-1,3,5(10)-trien-17-one in 44 ml of DMF is stirred at 80°C with 1.2 g of methyl-[3-(4,4,5,5,5-pentafluoropentyl-thio)-propyl]-amine. After 6.5 hours, the reaction mixture is mixed with water. It is extracted with ethyl

acetate, washed with saturated sodium chloride solution and concentrated by evaporation in a vacuum. After the crude product is chromatographed on silica gel with a methylene chloride-methanol gradient, 1.3 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one is obtained as an oil.

1) 11 β -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17 β -ol

350 mg of sodium borohydride is added in portions to 2.0 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one in 17 ml of THF, 10 ml of ethanol and 4.2 ml of water at 0°C. After 30 minutes, the reaction mixture is stirred into ice water, extracted with ethyl acetate, washed with saturated sodium chloride solution and concentrated by evaporation in a vacuum. 1.7 g of crude 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17 β -ol is obtained as a foam.

m) 11 β -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 1.6 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17 β -ol in 20 ml of methanol and 2 ml of water is stirred with 1.0 g of oxalic acid. After 3 hours, the reaction mixture is added to ice water. It is extracted with methylene chloride, washed with saturated sodium chloride solution, dried and concentrated by evaporation in a vacuum. After the crude product is chromatographed on silica gel with a methylene chloride-methanol gradient, 1.1 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol with a melting point of 95°C is obtained.

Example 13

11 β -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

580 mg of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol in 24 ml of methanol and 1.1 ml of water are stirred at room temperature with 350 mg of sodium periodate. After 1.5 hours, it is diluted with methylene chloride, washed with saturated sodium chloride solution, dried and concentrated by evaporation in a vacuum. The crude product is chromatographed

on silica gel with a methylene chloride-methanol gradient. 287 mg of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol with a melting point of 87°C is obtained.

Example 14

11 β -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 11 β -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one

2.0 g of 11 β -fluoro-3-(tetrahydropyran-2-yloxy-7 α -(5-p-toluenesulfonyloxypentyl)-estra-1,3,5(10)-trien-17-one in 40 ml of DMF is stirred with 2.1 g of methyl-[3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propyl]-amine at 80°C. After 7 hours, the reaction mixture is added to ice water, extracted with ethyl acetate, washed with saturated sodium chloride solution, dried and concentrated by evaporation in a vacuum. After the crude product is chromatographed on silica gel with a methylene chloride-methanol gradient, 1.1 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one is obtained as an oil.

b) 11 β -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17 β -ol

1.5 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one is mixed at 0°C in a mixture of 13 ml of THF, 7.5 ml of ethanol and 3.2 ml of water in portions with 270 mg of sodium borohydride. After 90 minutes, water is added, it is extracted with ethyl acetate, washed with saturated sodium chloride solution, dried and concentrated by evaporation in a vacuum. 1.5 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17 β -ol is obtained as a crude product.

c) 11 β -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

1.4 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17 β -ol is stirred in 18 ml of methanol and 1.8 ml of water at room temperature with 900 mg of oxalic acid. After 4 hours, the reaction mixture is stirred into ice water. The precipitated product is taken up in methylene chloride, washed with water, dried and concentrated by evaporation in a vacuum. After the crude product is chromatographed on silica gel with a methylene chloride-methanol

gradient, 325 mg of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol with a melting point of 70°C is obtained.

Example 15

16 α -Fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 7 α -(5-Chloropentyl)-estr-4-ene-3,17-dione

11.6 g of magnesium chips is suspended in 150 ml of anhydrous tetrahydrofuran, and the Grignard reagent is prepared with 58.8 ml of 1-bromo-5-chloro-pentane in 40 ml of anhydrous tetrahydrofuran. It is stirred for 30 minutes at room temperature, diluted with another 100 ml of anhydrous tetrahydrofuran and cooled to -70°C. Then, the solution of 3.04 g of copper(I)-bromide-dimethylsulfide complex in 72 ml of 1,3-dimethyltetrahydro-2(1H)-pyrimidinone (DMPU) and 150 ml of tetrahydrofuran are added in drops at an internal temperature of -65 to -70°C. Ultimately, the solution of 50 g of estra-4,6-diene-3,17-dione (*Steroids* Vol. 1, 1963, 223) and 75 ml of trimethylchlorosilane in 700 ml of anhydrous tetrahydrofuran is added within 2.5 hours. The mixture can be heated slowly to room temperature in a cooling bath while being stirred, acidified the next morning with 48 ml of acetic acid while being cooled with ice and mixed with ethyl acetate after being stirred for 15 minutes. The organic phase is extracted three times with saturated ammonium chloride solution, the aqueous phase is

extracted with ethyl acetate, then the combined organic phases are washed with sodium bicarbonate solution, dried with magnesium sulfate and concentrated by evaporation in a vacuum. The residue of 53 g is chromatographed on silica gel with hexane/dichloromethane and ethyl acetate, yield 35 g of 7 α -(5-chloropentyl)-estr-4-ene-3,17-dione

The same product is obtained from 8.05 g of 7 α -(5-hydroxypentyl)-estr-4-ene-3,17-dione (Example 1b) by a 3.5-hour reaction with 8.66 g of triphenylphosphine in 85 ml of carbon tetrachloride and 30 ml of acetonitrile at room temperature. The reaction mixture is diluted with dichloromethane, shaken out with saturated bicarbonate solution and with saturated common salt solution, dried with sodium sulfate and concentrated by evaporation in a vacuum. The residue is chromatographed on silica gel with dichloromethane and ethyl acetate, whereby 4.08 g of 7 α -(5-chloropentyl)-estr-4-ene-3,17-dione is obtained, $[\alpha]_D^{22} = +68^\circ$ (c = 0.5% in chloroform)

b) 7 α -(5-Chloropentyl)-3-hydroxy-estra-1,3,5(10)-trien-17-one

18.96 g of 7 α -(5-chloropentyl)-estr-4-ene-3,17-dione is dissolved in 350 ml of anhydrous acetonitrile and mixed under inert gas at 80°C with a solution of 4.36 g of lithium bromide and 22.5 g of copper(II) bromide in 390 ml of anhydrous acetonitrile. It is stirred for 5 more minutes, the mixture is cooled in an ice bath and mixed with water and ethyl acetate. The organic phase is shaken out with saturated sodium bicarbonate solution, the aqueous phase with ethyl acetate, the combined

organic phases with saturated common salt solution, dried with sodium sulfate and concentrated by evaporation in a vacuum. The raw yield of 19.1 g is chromatographed on silica gel in hexane and ethyl acetate, whereby 10.0 g of oily 7 α -(5-chloropentyl)-3-hydroxy-estra-1,3,5(10)-trien-17-one is obtained, which can be crystallized from hexane/dichloromethane.

Melting point 143.5°C, $[\alpha]_D^{22} = +112^\circ$ (c = 0.5% in chloroform)

c) Bis-3,17-trimethylsilyloxy-7 α -(5-chloropentyl)-estra-1,3,5(10),16-tetraene

5.65 g of 7 α -(5-chloropentyl)-estra-1,3,5(10)-trien-3-ol-17-one, 9 ml of triethylamine and 9 ml of trifluoromethanesulfonic acid trimethylsilyl ester are dissolved in 75 ml of benzene, and it is refluxed for 2 hours. After cooling, it is diluted with hexane, the upper phase is shaken out with saturated sodium bicarbonate solution and with saturated common salt solution, dried with sodium sulfate, and concentrated by evaporation in a vacuum, and it yields bis-3,17-trimethylsilyloxy-7 α -(5-chloropentyl)-estra-1,3,5(10),16-tetraene as an oil.

d) 7 α -(5-Chloropentyl)-16 α -fluoro-estra-1,3,5(10)-trien-3-ol-17-one

The product of the test above is dissolved in 150 ml of anhydrous dichloromethane and mixed with 14.2 g of N-fluorobenzenesulfonimide. After 2 hours of stirring at room temperature, 50 ml of 8% sulfuric acid is added, it is stirred intensively for another 3 hours, and then the phases are

separated. The water phase is shaken out twice with dichloromethane, the organic phase is shaken out in succession with saturated sodium bicarbonate and sodium chloride solution, dried with sodium sulfate and concentrated by evaporation in a vacuum. The crude product of 15.3 g is chromatographed on silica gel with dichloromethane/diisopropyl ether, whereby 2.92 g of 7α -(5-chloropentyl)- 16α -fluoro-estra-1,3,5(10)-trien-3-ol-17-one is obtained as an oil. The substance can be crystallized from diisopropyl ether, melting point 176°C , $[\alpha]_D^{22} = +114^{\circ}$ ($c = 0.5\%$ in chloroform).

e) 7α -(5-Chloropentyl)- 16α -fluoro- 17α -methyl-estra-1,3,5(10)-triene-3,17 β -diol

3.0 g of 7α -(5-chloropentyl)- 16α -fluoro-estra-1,3,5(10)-trien-3-ol-17-one is dissolved in 300 ml of anhydrous toluene under inert gas and mixed with 3 portions of 20 ml each of a 1.5-molar solution of methyllithium and lithium bromide in ether at room temperature at an interval of 15 minutes. After another 30 minutes, the reaction mixture is stirred into a semi-saturated ammonium chloride solution while being cooled with ice, acidified with 8% sulfuric acid and extracted with ethyl acetate. The combined organic phases are shaken out with sodium chloride solution, dried with sodium sulfate and concentrated by evaporation in a vacuum. The crude product of 3.2 g is chromatographed on silica gel with hexane and methyl-*tert*-butyl ether. The polar fraction of 1.21 g is 7α -(5-chloropentyl)- 16α -fluoro- 17α -methyl-estra-1,3,5(10)-triene-3,17 β -diol, which

crystallizes from diisopropyl ether/hexane, melting point 70°C, $[\alpha]_D^{22} = +7^\circ$ (c = 0.5% in chloroform).

f) 16 α -Fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

40.8 mg of 7 α -(5-chloropentyl)-16 α -fluoro-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol is dissolved in 0.5 ml of dimethylformamide, and the solution of 58 mg of 3-(N-methylamino)-propyl-4,4,5,5,5-pentafluoropentyl-sulfide and 13 mg of lithium iodide is added and heated for 17 hours to 100°C under inert gas. After cooling, the mixture is mixed with ethyl acetate, shaken out in succession with saturated sodium bicarbonate and common salt solution, dried with sodium sulfate, and the solvent is evaporated in a vacuum. The residue is chromatographed on silica gel with ethyl acetate/methanol, yield 25 mg of 16 α -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol as an oil.

Example 16

16 α -Fluoro-17 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 α -diol

As a nonpolar product of the chromatography in Example 15e), 7 α -(5-chloropentyl)-16 α -fluoro-17 β -methyl-estra-1,3,5(10)-triene-3,17 α -diol accumulates in an amount of 0.48 g. By

crystallization from diisopropyl ether/hexane, crystals with a melting point of 65°C and $[\alpha]_D^{22} = +5^\circ$ (c = 0.5% in chloroform) are obtained.

41 mg of the crystals are reacted as described in Example 15f), whereby 23 mg of 16 α -fluoro-17 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 α -diol is obtained.

Example 17

16 α -Fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

By oxidation with sodium periodate, as described in Example 2, 38 mg of 16 α -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained from 72 mg of 16 α -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol.

Example 18

16 α -Fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

As described in Example 15f), 40.8 mg of 7 α -(5-chloropentyl)-16 α -fluoro-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol in dimethylformamide is reacted with 70 mg of 3-(N-methylamino)-propyl-4,4,5,5,5-pentafluoropentylsulfone. After

working-up, 21 mg of 16 α -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as an oil.

Example 19

16 α -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 7 α -(5-Chloropentyl)-16 α -fluoro-estra-1,3,5(10)-triene-3,17 β -diol and 7 α -(5-chloropentyl)-16 α -fluoro-estra-1,3,5(10)-triene-3,17 α -diol

392 mg of 7 α -(5-chloropentyl)-16 α -fluoro-estra-1,3,5(10)-trien-3-ol-17-one, Example 15d), in 2 ml of anhydrous tetrahydrofuran is dissolved, and 1.1 ml of a 1-molar solution of lithium tri-*tert*-butoxyaluminum hydride in tetrahydrofuran is added while being cooled in an ice bath. It is allowed to stir for 30 minutes at 0°C, then mixed with water and 8% sulfuric acid until a weakly acidic reaction is achieved, and it is extracted three times with ethyl acetate. The organic phase is washed with saturated sodium chloride solution, dried with sodium sulfate and evaporated to the dry state in a vacuum. The crude product is chromatographed on silica gel with hexane/ethyl acetate, whereby 118 mg of 7 α -(5-chloropentyl)-16 α -fluoro-estra-1,3,5(10)-triene-3,17 β -diol and 138 mg of 7 α -(5-chloropentyl)-16 α -fluoro-estra-1,3,5(10)-triene-3,17 α -diol is obtained, both as solid foam.

b) 16 α -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

By reaction of 100 mg of 7 α -(5-chloropentyl)-16 α -fluoro-estra-1,3,5(10)-triene-3,17 β -diol with 3-(N-methylamino)-propyl-4,4,5,5,5-pentafluoropentyl sulfide, as described in Example 15f), 83 mg of 16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as solid foam.

Example 20

16 α -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 α -diol

Analogously, 75 mg of 16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propyl-amino]-pentyl}-estra-1,3,5(10)-triene-3,17 α -diol is obtained as a foam in the same way from 100 mg of 7 α -(5-chloropentyl)-16 α -fluoro-estra-1,3,5(10)-triene-3,17 α -diol.

Example 21

16 α -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

By oxidation of 85 mg of 16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol with sodium periodate, as described in Example 17, 47 mg of 16 α -fluoro-7 α -{5-[N-methyl-N-3-

(4,4,5,5,5-pentafluoropentyl-sulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as a foam.

Example 22

16 α -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

As described in Example 15f), 65 mg of 7 α -5-(chloropentyl)-16 α -fluoro-estra-1,3,5(10)-triene-3,17 β -diol is reacted with 90 mg of 3-(N-methylamino)-propyl-4,4,5,5,5-pentafluoropentyl-sulfone, and 53 mg of 16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as an oil.

Example 23

7 α -{5-[N-Methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol
a) 7 α -(5-tert-Butyl-dimethylsilyloxypentyl)-estr-4-ene-3,17-dione

In 34 ml of absolute tetrahydrofuran, 8.9 g of magnesium chips with 103 g of 1-bromo-5-tert-butyldimethylsilyloxypentane, dissolved in 110 ml of tetrahydrofuran, are reacted to form the Grignard reagent. 2.5 g of copper(I) bromide-dimethyl sulfide complex and a mixture of 60 ml of 1,3-dimethyl-3,4,5,6-tetrahydro-2(1H)-pyrimidinone and 70 ml of tetrahydrofuran are added to this solution at -70°C to -65°C, and the resulting

suspension is stirred for 30 more minutes at -70°C under argon atmosphere.

Then, at -70°C to -65°C , a solution of 50 g of *estra-4,6-diene-3,17-dione* [Steroids Vol. 1, 1963, 233-249] in 730 ml of absolute tetrahydrofuran and 62.7 ml of chlorotrimethylsilane is added in drops, and the mixture is stirred overnight at -70°C . For working-up, the reaction mixture is mixed with 48 ml of glacial acetic acid at -15°C , and, after 15 minutes of stirring, it is poured at this temperature into a mixture of saturated ammonium chloride solution and ethyl acetate. The organic phase is separated, and washed neutral in succession with saturated ammonium chloride solution, saturated sodium bicarbonate solution and ultimately with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation.

The residue is chromatographed on silica gel with dichloromethane/acetone. 47 g of *7 α -(5-tert-butyl-dimethylsilyloxypentyl)-estr-4-ene-3,17-dione* is obtained as a yellow oil. $[\alpha]_D^{22} = +62.2^{\circ}$ ($c = 0.545$ in chloroform).

b) 3-Hydroxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one

According to the procedure indicated in Example 1b-1i, 62.7 g of *7 α -(5-tert-butyl-dimethylsilyloxypentyl)-estr-4-ene-3,17-dione* is reacted to form 15.8 g of *3-hydroxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one*.

c) 3-Benzylloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one

A solution of 2.85 g of 3-hydroxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one in 57 ml of acetone is mixed with 3.25 g of cesium carbonate and 1.14 ml of benzyl bromide, and the mixture is refluxed for 1 hour. The reaction mixture is concentrated by evaporation, the residue is mixed with water, shaken out with ethyl acetate, the organic phase is dried on sodium sulfate and concentrated by evaporation. The residue is chromatographed on silica gel with hexane/ethyl acetate. 3.12 g of 3-benzylloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one is obtained as a foam.

d) 17-Acetoxy-7 α -(5-acetoxypentyl)-3-benzylloxy-estra-1,3,5(10),14,16-pentaene

A solution of 6.12 g of 3-benzylloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),15-tetraen-17-one in 717 ml of acetic anhydride is stirred with 920 mg of p-toluenesulfonic acid for 1 hour at room temperature. The reaction mixture is worked up according to the procedure that is indicated in Example 1j, and the crude product is chromatographed on silica gel with hexane/ethyl acetate. 4.6 g of 17-acetoxy-7 α -(5-acetoxypentyl)-3-benzylloxy-estra-1,3,5(10),14,16-pentaene is obtained as an oil.

e) 7 α -(5-Acetoxypropyl)-3-benzyloxy-estra-1,3,5(10),14-tetraen-17 β -ol

A solution of 1.25 g of sodium borohydride in 90 ml of ethanol and 18 ml of water is added in drops to a solution of 4.58 g of 17-acetoxy-7 α -(5-acetoxypropyl)-3-benzyloxy-estra-1,3,5(10),14,16-pentaene in 26.8 ml of tetrahydrofuran and 161 ml of ethanol at room temperature, and the mixture is stirred for 1 hour. The reaction mixture is mixed with 4 ml of glacial acetic acid, concentrated by evaporation, and the residue is taken up in ethyl acetate. The organic phase is washed with sodium bicarbonate, dried on sodium sulfate and concentrated by evaporation. The residue is chromatographed on silica gel with hexane/ethyl acetate. 2.16 g of 7 α -(5-acetoxypropyl)-3-benzyloxy-estra-1,3,5(10),14-tetraen-17 β -ol is obtained as a foam.

f) 3-Benzyloxy-7 α -(5-hydroxypropyl)-estra-1,3,5(10),14-tetraen-17 β -ol

2.16 g of 7 α -(5-acetoxypropyl)-3-benzyloxy-estra-1,3,5(10),14-tetraen-17 β -ol is saponified with 38 ml of 1N methanolic potassium hydroxide solution overnight at room temperature. The reaction mixture is poured into ice-cold saturated common salt solution, the precipitate is suctioned off, taken up in dichloromethane, washed with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation. 1.86 g of 3-benzyloxy-7 α -(5-hydroxypropyl)-estra-1,3,5(10),14-tetraen-17 β -ol is obtained as a foam.

g) 3-Benzylloxy-7 α -(5-tosyloxypentyl)-estra-1,3,5(10),14-tetraen-17 β -ol

Under the conditions of Example 10, 3.03 g of 3-benzylloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10),14-tetraen-17 β -ol with 2.31 g of p-toluenesulfonic acid anhydride in 58 ml of pyridine is reacted, worked up and chromatographed on silica gel. 3 g of 3-benzylloxy-7 α -(5-tosyloxy-pentyl)-estra-1,3,5(10),14-tetraen-17 β -ol is obtained as a foam.

h) 3-Benzylloxy-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraen-17 β -ol

A solution of 2 g of 3-benzylloxy-7 α -(5-tosyloxypentyl)-estra-1,3,5(10),14-tetraen-17 β -ol in 28 ml of ethyl methyl ketone is stirred with 1.77 g of N-methyl-3-(4,4,5,5,5-pentafluoropentylthio)-propylamine in the presence of 950 mg of potassium carbonate and 230 mg of potassium iodide for 5 hours at a bath temperature of 80°C. The reaction mixture is poured into common salt solution, extracted with ethyl acetate, washed with common salt solution, dried on sodium sulfate and concentrated by evaporation. The residue is chromatographed on silica gel with hexane/ethyl acetate. 1.93 g of 3-benzylloxy-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraen-17 β -ol is obtained as a resin. $[\alpha]_D^{22} = +47.3^\circ$ (c = 0.505 in chloroform)

i) 7 α -{5-[N-Methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol

10.2 ml of a 1.2-molar solution of diisobutylaluminum hydride in toluene is added in drops to a solution of 850 mg of 3-benzyloxy-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraen-17 β -ol in 10.2 ml of toluene at room temperature, and the mixture is heated for 5 hours at a bath temperature of 120°C. While being stirred and under argon atmosphere, the reaction mixture is added in drops to a mixture of saturated common salt solution and 2N sulfuric acid, extracted three times with ethyl acetate, the organic phase is washed twice with 2N sulfuric acid and three times with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation. The residue is chromatographed on silica gel with hexane/ethyl acetate/0-30% methanol. 670 mg of 7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol is obtained as a foam. $[\alpha]_D^{22} = +43^\circ$ (c = 0.520 in chloroform/methanol).

Example 24

7 α -{5-[N-Methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol

Under the conditions of Example 2, 400 mg of 7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol with 177 mg of sodium periodate is reacted, worked up, and the crude product is

chromatographed on silica gel with ethyl acetate/methanol. 287 mg of the title compound is obtained as a foam. $[\alpha]_D^{22} = +30.7^\circ$ (c = 0.530 in chloroform/methanol).

Example 25

7 α -{5-[N-Methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol

a) 3-Benzoyloxy-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraen-17 β -ol

Under the conditions of Example 23h, 1 g of 3-benzoyloxy-7 α -(5-tosyloxypropyl)-estra-1,3,5(10),14-tetraen-17 β -ol is reacted with 990 mg of N-methyl-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propyl-amine, worked up, and the crude product is chromatographed on silica gel with ethyl acetate/methanol. 960 mg of 3-benzoyloxy-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraen-17 β -ol is obtained as an oil. $[\alpha]_D^{22} = +48.5^\circ$ (c = 0.535 in chloroform)

b) 7 α -{5-[N-Methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol

A solution of 100 mg of 3-benzoyloxy-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraen-17 β -ol in 1 ml of dichloromethane is mixed with 0.2 ml of dimethylaniline and 73 mg of aluminum chloride while being cooled in an ice bath, and it is stirred for

1 hour at this temperature. The reaction mixture is poured onto 1N hydrochloric acid, shaken out with ethyl acetate, washed with sodium bicarbonate solution and saturated common salt solution, dried on sodium sulfate and concentrated by evaporation. The crude product is chromatographed on silica gel with dichloromethane/0-10% of methanol. 74 mg of the title compound is obtained as a foam. $[\alpha]_D^{22} = +36^\circ$ (c = 0.525 chloroform/methanol).

Example 26

7 α -{5-[(2S)-2-(4,4,5,5,5-Pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 7 α -(5-Acetoxypentyl)-3-benzyloxy-estra-1,3,5(10)-trien-17-one

A solution of 6.5 g of 7 α -(5-acetoxypentyl)-3-hydroxy-estra-1,3,5(10)-trien-17-one (Example 1d) in 65 ml of dimethylformamide is mixed with 3.3 ml of benzyl chloride, 8.7 g of cesium carbonate and 400 mg of sodium iodide, and it is stirred overnight at room temperature. The reaction mixture is poured into water, shaken out with ethyl acetate, the organic phase is washed with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation. The residue is chromatographed on silica gel with hexane/ethyl acetate. 7.26 g of 7 α -(5-acetoxypentyl)-3-benzyloxy-estra-1,3,5(10)-trien-17-one is obtained as an oil.

b) 3-Benzyloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10)-trien-17-one

A solution of 7.26 g of α -(5-acetoxypentyl)-3-benzyloxy-estra-1,3,5(10)-trien-17-one in 80 ml of methanol and 3 ml of tetrahydrofuran is saponified with 22.2 ml of 2N sodium hydroxide solution overnight at room temperature. The reaction solution is poured into 2N hydrochloric acid, shaken out with ethyl acetate, the organic phase is washed with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation. 6.7 g of 3-benzyloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10)-trien-17-one is obtained as a foam.

c) 3-Benzyloxy-7 α -(5-tosyloxypentyl)-estra-1,3,5(10)-trien-17-one

Under the conditions of Example 10, 6.5 g of 3-benzyloxy-7 α -(5-hydroxypentyl)-estra-1,3,5(10)-triene is reacted with 7.14 g of p-toluenesulfonic acid anhydride, worked up and chromatographed on silica gel with hexane/ethyl acetate. 7.45 g of 3-benzyloxy-7 α -(5-tosyloxypentyl)-estra-1,3,5(10)-trien-17-one is obtained as a foam. $[\alpha]_D^{22} = +80.6^\circ$ (c = 0.620 in chloroform).

d) 3-Benzyloxy-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one

Under the conditions of Example 23h, 4.58 g of 3-benzyloxy-7 α -(5-tosyloxypentyl)-estra-1,3,5(10)-trien-17-one is reacted with 3.17 g of (2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidine, worked up, and the crude product is chromatographed

on silica gel with hexane/ethyl acetate. 3.9 g of 3-benzyloxy-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one is obtained as an oil. $[\alpha]_D^{22} = +32.5^\circ$ (c = 0.117 in chloroform).

e) 3-Hydroxy-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one

Under the conditions of Example 6f, 2.05 g of 3-benzyloxy-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one is debenzylated. 1.25 g of 3-hydroxy-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one is obtained as an oil. $[\alpha]_D^{22} = +22.7^\circ$ (c = 0.475 in chloroform).

f) 7 α -{5-[(2S)-2-(4,4,5,5,5-Pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

Under the conditions of Example 8, 500 mg of 3-hydroxy-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one is reduced with 100 mg of sodium borohydride. 325 mg of the title compound is obtained as an oil. $[\alpha]_D^{22} = -8.7^\circ$ (c = 0.510 in methanol).

Example 27

7 α -{5-[(2R)-2-(4,4,5,5,5-Pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

Similar to what is described in Example 26d-f, 612 mg of the title compound is obtained as an oil from 2.3 g of 3-benzyloxy-7 α -(5-tosyloxypentyl)-estra-1,3,5(10)-trien-17-one (Example 26c) and 1.6 g of (2R)-2-(4,4,5,5,5-pentafluoro-pentylthiomethyl)-pyrrolidine.

Example 28

17 α -Methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 7 α -(5-Chloropentyl)-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol

A suspension of 5.21 g of anhydrous cerium(III) chloride in 53.2 ml of tetrahydrofuran is stirred for 2 hours at room temperature, 7 ml of a methylmagnesium bromide solution (3M in diethyl ether) is added in drops at 0°C, and the mixture is stirred for 30 minutes at 0°C and for 15 minutes at room temperature. Then, a solution of 1 g of 7 α -(5-chloropentyl)-3-hydroxy-estra-1,3,5(10)-trien-17-one (Example 15b) in 24 ml of tetrahydrofuran is added, and it is stirred for another 30 minutes at room temperature. The reaction mixture is poured onto ice-cold, saturated ammonium chloride solution, shaken out with ethyl acetate, the organic phase is dried on sodium sulfate and concentrated by evaporation. The residue is chromatographed on silica gel with hexane/ethyl acetate. 753 mg of 7 α -(5-

chloropentyl)-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol is obtained as a foam. $[\alpha]_D^{22} = +27.3^\circ$ (c = 0.515 in chloroform).

b) 7 α -(5-Iodopentyl)-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 735 mg of 7 α -(5-chloropentyl)-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol in 4 ml of ethyl methyl ketone is mixed with 5.6 g of sodium iodide and heated for 17 hours at a bath temperature of 80°C. The reaction mixture is poured into water, shaken out with ethyl acetate, the organic phase is washed with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation. 834 mg of 7 α -(5-iodopentyl)-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol is obtained as a foam. $[\alpha]_D^{22} = +20.2^\circ$ (c = 0.500 in chloroform).

c) 17 α -Methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 453 mg of 7 α -(5-iodopentyl)-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol and 390 mg of (2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidine in 8 ml of N-methyl-2-pyrrolidinone is heated for 4 hours to a bath temperature of 80°C. The cooled reaction mixture is poured into saturated sodium bicarbonate solution, shaken out with ethyl acetate, the organic phase is washed with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation. The residue is chromatographed on silica gel with

dichloromethane/ethyl acetate. 413 mg of the title compound is obtained as a foam. $[\alpha]_D^{22} = -25.8^\circ$ ($c = 0.500$ in chloroform).

Example 29

11 β -Fluoro-7 α -{5-[2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) **7 α -(5-Chloropentyl)-11 β -fluoro-estr-4-ene-3,17-dione**

A solution of 78.7 g of 11 β -fluoro-7 α -(5-hydroxypentyl)-estr-4-ene-3,17-dione (Example 12e) in 1.4 l of carbon tetrachloride and 475 ml of acetonitrile is stirred with 71 g of triphenylphosphine for 8.5 hours at room temperature. Then, it is extracted with water, aqueous sodium bicarbonate and common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/ethyl acetate. 48.0 g of 7 α -(5-chloropentyl)-11 β -fluoro-estr-4-ene-3,17-dione is obtained as crystals with a melting point of 51-53°C. $[\alpha]_D^{22} = +78.5^\circ$ ($c = 0.5\%$ in chloroform).

b) **7 α -(5-Chloropentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one**

A solution of 10.34 g of lithium bromide and 53.2 g of copper(II) bromide in 280 ml of acetonitrile is added in drops to a solution of 47 g of 7 α -(5-chloropentyl)-11 β -fluoro-estr-4-ene-3,17-dione in 470 ml of acetonitrile at a bath temperature of 80°C. After 20 ml is added, the bleaching of the solution is awaited, and the remainder of the solution is added in 12 minutes and then stirred for 5 more minutes at a bath temperature of

80°C. Then, it is cooled to 0°C, mixed with sodium bicarbonate solution, added to water, extracted 4 times with ethyl acetate, washed neutral, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/ethyl acetate. 25.3 g of 7 α -(5-chloropentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one is obtained. $[\alpha]_D^{22} = +115.4^\circ$ (c = 0.5% in chloroform).

c) 11 β -Fluoro-3-hydroxy-7 α -{5-[2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one

A solution of 785.9 mg of 7 α -(5-chloropentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one in 7 ml of N-methyl-2-pyrrolidinone is mixed with 535.5 mg of lithium iodide and 520 mg of (2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidine, and it is stirred for 2.5 hours at a bath temperature of 100°C. Then, it is poured onto water, extracted 3 times with diethyl ether, washed neutral, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 525 mg of pure 11 β -fluoro-3-hydroxy-7 α -{5-[2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one is obtained. $[\alpha]_D^{22} = +29.3^\circ$ (c = 0.5% in chloroform).

d) 11 β -Fluoro-7 α -{5-[2-(4,4,5,5,5-pentafluoro-pentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17-diol

500 mg of 11 β -fluoro-3-hydroxy-7 α -{5-[2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one in 5 ml of tetrahydrofuran, 2.75 ml of ethanol and 1.1 ml of water, and 100 mg of sodium borohydride is added at a bath temperature of 0°C, and it is stirred for 0.5 hour at room temperature. Then, it is added to water, extracted 3 times with ethyl acetate, washed neutral with saturated common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 441.3 mg of 11 β -fluoro-7 α -{5-[2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as crystals with a melting point of 174-176°C. $[\alpha]_D^{22} = -14.9^\circ$ (c = 0.5% in pyridine).

Example 30

11 β -Nitrooxy-7 α -(9-[4,4,5,5,5-pentafluoropentanesulfonyl]-nonyl)-estra-1,3,5(10)-triene-3,17 β -diol

a) 3,17 β -Diacetyloxy-7 α -(9-[4,4,5,5,5-pentafluoropentanesulfonyl]-nonyl)-estra-1,3,5(10)-triene

6.28 g of 7 α -(9-[4,4,5,5,5-pentafluoropentanesulfinyl]-nonyl)-estra-1,3,5(10)-triene-3,17 β -diol is dissolved in 30 ml of pyridine, mixed with 15 ml of acetic anhydride while being cooled with water and then allowed to stir for 5 hours at room temperature.

For working-up, the reaction solution is poured onto ice water, the diacetate is extracted with ethyl acetate, the organic phase is washed with dilute sulfuric acid, water, saturated common salt solution and dried on sodium sulfate. As a crude product, an oil, which is taken up in 100 ml of acetic acid, is obtained, and it is mixed with 15 g of sodium perborate. After five hours of stirring at room temperature, the reaction is complete.

The reaction mixture is poured onto ice water and then extracted with ethyl acetate. The organic phase is freed from acid residues with aqueous bicarbonate solution. After drying on sodium sulfate, it is filtered, concentrated by evaporation and chromatographed on silica gel (hexane/ethyl acetate, 7:3). 6.83 g of product is obtained as a foam.

b) 3,17 β -Diacetyloxy-11 β -nitrooxy-7 α -(9-[4,4,5,5,5-pentafluoropentanesulfonyl]-nonyl)-estra-1,3,5(10)-trien-9-ol

18.6 g of cerium ammonium nitrate is added to a solution of 3.0 g of 3,17 β -diacetyloxy-7 α -(9-[4,4,5,5,5-pentafluoropentanesulfonyl]-nonyl)-estra-1,3,5(10)-triene in 50 ml of aqueous acetic acid (90%), and it is stirred for 4 hours at room temperature.

For working-up, the reaction solution is poured onto ice water, extracted with ethyl acetate, and the organic phase is washed neutral with aqueous bicarbonate solution. Then, it is washed with saturated common salt solution and dried on sodium sulfate.

The crude product is chromatographed on silica gel (hexane/ethyl acetate, 7:3). 2.0 g of product is obtained as a yellow-colored foam.

c) 3,17 β -Diacetyloxy-11 β -nitrooxy-7 α -(9-[4,4,5,5,5-pentafluoropentanesulfonyl]-nonyl)-estra-1,3,5(10)-triene

For reductive removal of the 9 α -hydroxy group in 3,17 β -diacetyloxy-11 β -nitrooxy-7 α -(9-[4,4,5,5,5-pentafluoropentanesulfonyl]-nonyl)-estra-1,3,5(10)-triene-9-ol, 2.0 g of starting material is dissolved in 25 ml of dichloromethane, cooled to -15°C and mixed successively with 15 ml of triethylsilane and 2.2 ml of boron trifluoride etherate. After one hour of stirring at -15°C, the cold bath is removed and allowed to thaw to room temperature.

For working-up, it is poured onto ice water, extracted with dichloromethane, the organic phase is washed with aqueous bicarbonate solution, saturated common salt solution and dried on sodium sulfate.

The crude product is chromatographed on silica gel (hexane/ethyl acetate, 9:1), yield 1.3 g of foam.

d) 11 β -Nitrooxy-7 α -(9-[4,4,5,5,5-pentafluoropentanesulfonyl]-nonyl)-estra-1,3,5(10)-triene-3,17 β -diol

For saponification, 1.0 g of 3,17 β -diacetyloxy-11 β -nitrooxy-7 α -(9-[4,4,5,5,5-pentafluoropentane-sulfonyl]-nonyl)-estra-1,3,5(10)-triene is dissolved in 50 ml of methanol, mixed with 20

ml of 3% methanolic potassium hydroxide solution and allowed to stand for 4 hours at room temperature.

The reaction mixture is poured into citric acid ice water and then extracted with ethyl acetate. After the organic phase is washed with water and saturated common salt solution, it is dried on sodium sulfate.

The crude product is chromatographed on silica gel (hexane/ethyl acetate, gradient to 3:2), yield 0.53 g as an oil.

Example 31

11 β -Fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 7 α -(5-Chloropentyl)-11 β -fluoro-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol

Under the conditions of Example 28a, 750 mg of 7 α -(5-chloropentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one (Example 29b) is reacted with 4.9 ml of methylmagnesium bromide solution (3 M in diethyl ether), worked up and chromatographed. 561 mg of 7 α -(5-chloropentyl)-11 β -fluoro-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol is obtained as a foam. $[\alpha]_D^{22} = +51.6^\circ$ (c = 0.515 in chloroform).

b) 11 β -Fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

Under the conditions of Example 15f, 408 mg of 7 α -(5-chloropentyl)-11 β -fluoro-17 α -methyl-estra-1,3,5(10)-triene-3,17 β -diol in 5 ml of N-methyl-2-pyrrolidinone is reacted in the presence of 130 mg of lithium iodide with 606 mg of (2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidine, worked up and chromatographed. 326 mg of the title compound is obtained as crystals with a melting point of 120-121°C.

$$[\alpha]_D^{22} = -5.8^\circ \text{ (c = 0.535\% in chloroform).}$$

Example 32

11 β -Fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

Under the conditions of Example 13, 260 mg of 11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol (Example 31b) is reacted with 151 mg of sodium periodate, worked up and chromatographed. 129 mg of the title compound is obtained as an oil.

Example 33

3,17 β -Diacetoxy-11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene

Under the conditions of Example 3, 65 mg of 11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol (Example 31b) is acetylated with acetic anhydride, and the crude product is oxidized with sodium perborate tetrahydrate, as described in Example 4, worked up and chromatographed. 27 mg of the title compound is obtained as an oil.

Example 34

7 α -{5-[(2S)-2-(4,4,5,5,5-Pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

By oxidation with sodium periodate, 66 mg of the title compound, as described in Example 2, is obtained as an oil from 152 mg of 7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol (Example 26f). $[\alpha]_D^{22} = +11.8^\circ$ (c = 0.53% in methanol).

Example 35

7 α -{5-[(2S)-2-(4,4,5,5,5-Pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

Under the conditions of Example 3, 76 mg of 7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol (Example 26f) is acetylated

with acetic anhydride, and the crude product is oxidized, as described in Example 4, with sodium perborate tetrahydrate, worked up and chromatographed. 31 mg of the title compound is obtained as an oil. $[\alpha]_D^{22} = 30.6^\circ$ (c = 0.515% in methanol).

Example 36

11 β -Fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 11 β -Fluoro-3-hydroxy-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17-one

A solution of 2.0 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one in 20 ml of methanol and 2 ml of water is stirred at room temperature with 1.2 g of oxalic acid. After 2.5 hours, it is added to ice water, extracted with dichloromethane, washed with saturated common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 1.2 g of 11 β -fluoro-3-hydroxy-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17-one is obtained as a foam. $[\alpha]_D^{22} = +69^\circ$ (c = 0.5% in chloroform).

b) 11 β -Fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

33 ml of a 1.6-molar ethereal lithium methylate solution is added in drops to 5 g of 11 β -fluoro-3-hydroxy-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-17-one in 150 ml of tetrahydrofuran at room temperature. After 2.5 hours, saturated ammonium chloride solution is added while being cooled with ice, extracted with ethyl acetate, washed with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation in a vacuum. After chromatography on silica gel, which contains 2% triethylamine, with dichloromethane/methanol, 2.0 g of 11 β -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as crystals with a melting point of 83°C.

Example 37

11 β -Fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 500 mg of 11 β -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol in 20 ml of methanol and 0.9 ml of water is stirred at room temperature with 355 mg of sodium periodate for 3 hours. Then, it is poured onto ice water,

extracted with dichloromethane, washed with saturated common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 216 mg of 11 β -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as crystals with a melting point of 83.4°C.

Example 38

11 β -Fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 11 β -Fluoro-3-hydroxy-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17-one

A solution of 3 g of 7 α -(5-chloropentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one in 50 ml of dimethylformamide is stirred with 1.6 g of lithium iodide and 6.2 g of methyl-[3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propyl]-amine for 22 hours at 100°C. Then, it is extracted with ethyl acetate, washed with saturated common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 4.5 g of 11 β -fluoro-3-hydroxy-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17-one is obtained as a foam.

b) 11 β -Fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A suspension of 11.4 g of anhydrous cerium(III) chloride in 120 ml of tetrahydrofuran is stirred for 2 hours at room temperature under nitrogen, mixed at 0°C drop by drop with 17.5 ml of a 3-molar, ethereal methylmagnesium bromide solution, stirred for 30 minutes, a solution of 3.5 g of 11 β -fluoro-3-hydroxy-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-trien-17-one in 24 ml of tetrahydrofuran is added, and it is stirred for another 30 minutes. Then, saturated ammonium chloride solution is added, diluted with ethyl acetate, washed with saturated common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 2.2 g of 11 β -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as crystals with a melting point of 82.5°C.

Example 39

11 β -Fluoro-7 α -(5-[N-methyl-N-2-(4,4,5,5,5-pentafluoropentanesulfonyl)-ethylamino]-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol

a) 7 α -(5-Bromopentyl)-11 β -fluoro-estr-4-ene-3,17-dione

A solution of 33 g of 11 β -fluoro-7 α -(5-hydroxypentyl)-estr-4-ene-3,17-dione in 330 ml of dichloromethane is mixed at -5°C with 28.9 g of triphenylphosphine and 36.7 g of carbon tetrabromide, and it is stirred for 0.5 hour. Then, dichloromethane is added, and it is washed with water, saturated sodium bicarbonate and common salt solution. The organic phase is dried on sodium sulfate and concentrated by evaporation in a vacuum. Then, the crude product is chromatographed on silica gel with a hexane-ethyl acetate gradient. 28.5 g of 7 α -(5-bromopentyl)-11 β -fluoro-estr-4-ene-3,17-dione with a melting point of 75-76°C is obtained.

b) 7 α -(5-Bromopentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one

17.0 g of copper(II) bromide is added to 27.8 g of 7 α -(5-bromopentyl)-11 β -fluoro-estr-4-ene-3,17-dione in 190 ml of acetonitrile at 80°C. After 8 hours, the reaction mixture is stirred into water, extracted three times with ethyl acetate, washed twice with ammonium chloride, with sodium bicarbonate and common salt, dried and concentrated by evaporation in a vacuum. After the crude product is chromatographed on silica gel with a hexane-ethyl acetate gradient, 20.4 g of 7 α -(5-bromopentyl)-11 β -

fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one is obtained as colorless crystals with a melting point of 178°C.

c) 7 α -(5-Bromopentyl)-11 β -fluoro-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 16.2 g of 7 α -(5-bromopentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one in 162 ml of tetrahydrofuran as well as 90 ml of ethanol and 36 ml of water are mixed in portions at 0°C with 4.7 g of sodium borohydride and stirred for 2 hours at 0°C. Then, it is added to water, extracted four times with ethyl acetate, washed with water and common salt solution, dried on sodium sulfate and concentrated by evaporation in a vacuum. 17.1 g of crude product is obtained. After chromatography on silica gel with hexane/ethyl acetate, 15.6 g of pure 7 α -(5-bromopentyl)-11 β -fluoro-estra-1,3,5(10)-triene-3,17 β -diol is obtained.

d) 11 β -Fluoro-7 α -[5-(methylamino)-pentyl]-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 2 g of 7 α -(5-bromopentyl)-11 β -fluoro-estra-1,3,5(10)-triene-3,17 β -diol in 20 ml of dimethylformamide is stirred with 8 ml of a 40% aqueous methylamine solution for 3.5 hours at 80°C. Then, it is added to water, extracted three times with ethyl acetate, washed with water and common salt solution, dried on sodium sulfate and concentrated by evaporation in a vacuum. 1.77 g of 11 β -fluoro-7 α -[5-(methylamino)-pentyl]-estra-1,3,5(10)-triene-3,17 β -diol is obtained.

e) 11 β -Fluoro-7 α -{5-[N-methyl-N-2-(4,4,5,5,5-pentafluoropentanesulfonyl)-ethylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 440 mg of 11 β -fluoro-7 α -{5-(methylamino)-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol in 15 ml of methanol is stirred with 500 mg of 4,4,5,5,5-pentafluoropentylvinylsulfone for 1 hour at 90°C. Then, it is added to water, extracted three times with ethyl acetate, washed with water and common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 488 mg of 11 β -fluoro-7 α -{5-[N-methyl-N-2-(4,4,5,5,5-pentafluoropentanesulfonyl)-ethylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained as crystals with a melting point of 74-76°C.

The reacted intermediate stage 12k) has a strong antiestrogenic action:

Example 40

11 β -Fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-hydroxy-estra-1,3,5(10)-trien-17-one

A solution of 1.6 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-(tetrahydropyran-2-yloxy)-estra-1,3,5(10)-trien-17-one in 20 ml of methanol and 2 ml of water is stirred with 1.0 g of oxalic acid. After 3 hours, the reaction mixture is added to ice water. It is extracted with methylene chloride, washed with saturated sodium chloride solution, dried and concentrated by evaporation

in a vacuum. After the crude product is chromatographed on silica gel with a methylene chloride-methanol gradient, 1.1 g of 11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-hydroxy-estra-1,3,5(10)-trien-17-one is obtained. $[\alpha]_D^{22} = +69^\circ$ (c = 0.5% in chloroform)

Example 41

11 β -Fluoro-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-hexyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 7 α -(6-Chlorohexyl)-11 β -fluoro-estr-4-ene-3,17-dione

First, 30 ml of a solution that consists of 41 ml of 1-bromo-6-chlorohexane in 270 ml of THF is added to a suspension of 6.8 g of magnesium chips in 100 ml of THF. After the reaction starts, the remaining solution is added in drops in such a way that the internal temperature does not exceed 35°C. In a second flask, 48.1 g of lithium bromide is added to a suspension of 26.4 g of copper(I) iodide in 120 ml of THF at 0°C, whereby the internal temperature climbs to 40°C. Without cooling, 46.4 ml of 1,3-dimethyl-3,4,5,6-tetrahydro-(1H)-pyrimidin-2-one is now added and stirred for 30 minutes at 40°C. A clear solution is obtained, which is added in drops to the Grignard solution that is cooled to -40°C. Then, it is stirred for 30 more minutes at -30°C and mixed drop by drop at -50°C with a solution of 23.5 g of 11 β -fluoro-estra-4,6-diene-3,17-dione in 230 ml of THF, 24.6 ml of 1,3-dimethyl-3,4,5,6-tetrahydro-(1H)-pyrimidin-2-one and 55 ml of trimethylchlorosilane in such a way that the internal temperature does not exceed -40°C. It is stirred for 1 hour

cold, then 32 ml of glacial acetic acid is added in drops, the cooling bath is removed and stirred for 1 more hour at room temperature. For working-up, the reaction mixture is added to 1.5 l of water, diluted with the same amount of ethyl acetate, the precipitate is separated on Celite, rewashed with ethyl acetate, the aqueous phase is extracted 3 times with ethyl acetate, washed with sodium bicarbonate and common salt solution, dried on magnesium sulfate and concentrated by evaporation in a vacuum. After the crude product is chromatographed on silica gel with a hexane-ethyl acetate gradient, 25.2 g of 7 α -(6-chlorohexyl)-11 β -fluoro-estr-4-ene-3,17-dione is obtained.

b) 7 α -(6-Chlorohexyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one

28.1 g of copper(II) bromide and 5.4 g of lithium bromide in 105 ml of anhydrous acetonitrile are added to 25.2 g of 7 α -(6-chlorohexyl)-11 β -fluoro-estr-4-ene-3,17-dione in 175 ml of anhydrous acetonitrile at 80°C. After 15 minutes, the reaction mixture is cooled to 0°C, and 250 ml of saturated sodium bicarbonate solution is added in drops. Then, the solution is stirred into 1 liter of water, brought to pH = 6 with 2N hydrochloric acid, extracted 3 times with ethyl acetate, washed with common salt solution, dried on magnesium sulfate and concentrated by evaporation in a vacuum. Chromatography of the crude product on silica gel with a hexane-ethyl acetate gradient yields 5.7 g of 7 α -(6-chlorohexyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one as a foam.

c) 11 β -Fluoro-3-hydroxy-7 α -(6-iodohexyl)-estra-1,3,5(10)-trien-17-one

2.7 g of 7 α -(6-chlorohexyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one is dissolved in 40 ml of ethyl methyl ketone, mixed with 3.0 g of sodium iodide and stirred overnight at a bath temperature of 90°C. For working-up, the reaction mixture is cooled to room temperature, stirred into water, extracted 3 times with ethyl acetate, washed with common salt solution, dried on magnesium sulfate and concentrated by evaporation in a vacuum. 3.4 g of 11 β -fluoro-3-hydroxy-7 α -(6-iodohexyl)-estra-1,3,5(10)-trien-17-one is obtained as a crude product, which is used without further purification in the next stage.

d) 11 β -Fluoro-3-hydroxy-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-hexyl}-estra-1,3,5(10)-trien-17-one

2.5 g of 11 β -fluoro-3-hydroxy-7 α -(6-iodohexyl)-estra-1,3,5(10)-trien-17-one in 20 ml of anhydrous DMF is stirred at a bath temperature of 100°C with 2.0 g of methyl-[3-(4,4,5,5,5-pentafluoropentylthio)-propyl]-amine. After 2 hours, the reaction solution is poured into semi-saturated sodium bicarbonate solution, extracted 3 times with methylene chloride, dried on magnesium sulfate and concentrated by evaporation in a vacuum. The residue is chromatographed on silica gel with a methylene chloride-methanol gradient. 3.15 g of 11 β -fluoro-3-hydroxy-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-

propylamino]-hexyl}-estra-1,3,5(10)-trien-17-one is obtained as a foam.

e) 11 β -Fluoro-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-hexyl}-estra-1,3,5(10)-triene-3,17-diol

250 mg of 11 β -fluoro-3-hydroxy-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propyl-amino]-hexyl}-estra-1,3,5(10)-trien-17-one is dissolved in 4.5 ml of methanol and mixed at 0°C in portions with 60 mg of sodium borohydride. After 3 hours of stirring at room temperature, the solvent is drawn off in a vacuum, the residue is mixed with saturated common salt solution, extracted 3 times with methylene chloride, dried on magnesium sulfate and concentrated by evaporation in a vacuum. After chromatography on silica gel with a methylene chloride-methanol gradient, 165 mg of 11 β -fluoro-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-hexyl}-estra-1,3,5(10)-triene-3,17-diol is obtained as a foam, $[\alpha]_D = +37^\circ$ (c = 1.01 in chloroform).

Example 42

11 β -Fluoro-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-hexyl}-estra-1,3,5(10)-triene-3,17-diol

a) 11 β -Fluoro-3-hydroxy-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-hexyl}-estra-1,3,5(10)-trien-17-one

500 mg of 11 β -fluoro-3-hydroxy-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propyl-amino]-hexyl}-estra-1,3,5(10)-trien-17-one is dissolved in 17 ml of methanol and 3.3 ml of water, mixed with 262 mg of sodium periodate and stirred for 2 hours at room temperature. For working-up, the reaction mixture is mixed with semi-saturated common salt solution, extracted 3 times with methylene chloride, dried on magnesium sulfate and concentrated by evaporation in a vacuum. The residue is purified on silica gel with a methylene chloride-methanol gradient. 149 mg of 11 β -fluoro-3-hydroxy-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-hexyl}-estra-1,3,5(10)-trien-17-one is isolated as a foam, $[\alpha]_D = +45^\circ$ (c = 1.015 in chloroform).

b) 11 β -Fluoro-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-hexyl}-estra-1,3,5(10)-triene-3,17-diol

149 mg of 11 β -fluoro-3-hydroxy-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propyl-amino]-hexyl}-estra-1,3,5(10)-trien-17-one is dissolved in 3 ml of methanol and

mixed in portions with 35 mg of sodium borohydride. After 30 minutes of stirring at room temperature, the solvent is drawn off in a vacuum, the residue is mixed with water, extracted 3 times with methylene chloride, dried on magnesium sulfate and concentrated by evaporation in a vacuum. Preparative thin-layer chromatography with methylene chloride/methanol = 9/1 as a solvent provides 109 mg of 11 β -fluoro-7 α -(6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-hexyl}-estra-1,3,5(10)-triene-3,17-diol as a foam, $[\alpha]_D = +24^\circ$ (c = 0.51 in chloroform).

Example 43

11 β -Fluoro-7 α -(5-{{N-3-(furan-2-ylmethylthio)-propyl}-N-methylamino}-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol

a) 7 α -(5-Chloropentyl)-11 β -fluoro-estr-4-ene-3,17-dione

First, 20% of a solution of 39 ml of 1-bromo-5-chloropentane in 300 ml of THF is added to a suspension of 7.2 g of magnesium chips in 100 ml of THF under nitrogen. After the reaction starts, which can be achieved by adding iodine and dibromomethane, the remaining solution is added in drops in such a way that the internal temperature does not exceed 35°C. In a second flask, 51.2 g of lithium bromide is added to a suspension of 28.1 g of copper(I) iodide in 130 ml of THF at 0°C, whereby the internal temperature climbs to 40°C. Without cooling, 49.4 ml of 1,3-dimethyl-3,4,5,6-tetrahydro-(1H)-pyrimidin-2-one is now added and stirred for 15 minutes at 40°C. A clear solution is

obtained, which is added in drops to the Grignard solution that is cooled to -50°C . Then, it is stirred for 15 more minutes at -30°C and mixed at -70°C drop by drop with a solution of 25 g of 11 β -fluoro-estra-4,6-diene-3,17-dione in 260 ml of THF, 26 ml of 1,3-dimethyl-3,4,5,6-tetrahydro-(1H)-pyrimidin-2-one and 59 ml of trimethylchlorosilane in such a way that the internal temperature does not exceed -65°C . It is stirred for 30 minutes cold, then 34.7 ml of glacial acetic acid is added in drops, the cooling bath is removed, and it is stirred for 1 more hour at room temperature. For working-up, the reaction mixture is added to 1.5 l of water, diluted with the same amount of ethyl acetate, the precipitate is separated on Celite, rewashed with ethyl acetate, the aqueous phase is extracted 3 times with ethyl acetate, washed with sodium bicarbonate and common salt solution, dried on magnesium sulfate and concentrated by evaporation in a vacuum. After the crude product is chromatographed on silica gel with a hexane-ethyl acetate gradient, 22.1 g of 7 α -(5-chloropentyl)-11 β -fluoro-estr-4-ene-3,17-dione is obtained.

b) 7 α -(5-Chloropentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one

25.4 g of copper(II) bromide and 4.9 g of lithium bromide in 95 ml of anhydrous acetonitrile are added to 22.1 g of 7 α -(5-chloropentyl)-11 β -fluoro-estr-4-ene-3,17-dione in 160 ml of anhydrous acetonitrile at 80°C . After 20 minutes, the reaction mixture is cooled to 0°C , and 200 ml of saturated sodium bicarbonate solution is added in drops. Then, the solution is

stirred into 750 ml of water, brought to pH = 6 with 2N hydrochloric acid, extracted 3 times with ethyl acetate, washed with common salt solution, dried on magnesium sulfate and concentrated by evaporation in a vacuum. Chromatography of the crude product on silica gel with a hexane-ethyl acetate gradient yields 14.7 g of 7 α -(5-chloropentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one.

c) 11 β -Fluoro-3-hydroxy-7 α -(5-iodopentyl)-estra-1,3,5(10)-trien-17-one

5.0 g of 7 α -(5-chloropentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one is dissolved in 80 ml of ethyl methyl ketone, mixed with 5.7 g of sodium iodide and stirred overnight at a bath temperature of 90°C. For working-up, the reaction mixture is cooled to room temperature, stirred into water, extracted 3 times with ethyl acetate, washed with common salt solution, dried on magnesium sulfate and concentrated by evaporation in a vacuum. 6.8 g of 11 β -fluoro-3-hydroxy-7 α -(5-iodopentyl)-estra-1,3,5(10)-trien-17-one is obtained as a crude product, which is used without further purification in the next stage.

d) 11 β -Fluoro-3-hydroxy-7 α -[5-(methyldamino)-pentyl]-estra-1,3,5(10)-trien-17-one

5.1 g of methylamine is condensed in a solution of 6.8 g of 11 β -fluoro-3-hydroxy-7 α -(5-iodopentyl)-estra-1,3,5(10)-trien-17-one in 35 ml of anhydrous tetrahydrofuran at -78°C, and it is

stirred overnight at room temperature in a pressurized reactor. After the pressurized reactor was opened at -20°C , it was allowed to come to room temperature to be able to evaporate excess methylamine. Then, the reaction solution is added to saturated sodium bicarbonate solution, extracted 3 times with ethyl acetate, dried on magnesium sulfate and concentrated by evaporation in a vacuum. 6.7 g of 11 β -fluoro-3-hydroxy-7 α -[5-(methylamino)-pentyl]-estra-1,3,5(10)-trien-17-one is obtained as a crude product.

e) 11 β -Fluoro-7 α -(5-{[N-3-(furan-2-ylmethylthio)-propyl]-N-methyl-amino}-pentyl)-3-hydroxy-estra-1,3,5(10)-trien-17-one

526 mg of 11 β -fluoro-3-hydroxy-7 α -[5-(methylamino)-pentyl]-estra-1,3,5(10)-trien-17-one and 95 mg of 2-(3-chloro-propylthiomethyl)-furan are dissolved in 5 ml of ethyl methyl ketone, mixed with 112 mg of sodium iodide and 104 mg of potassium carbonate and stirred for 3 hours at a bath temperature of 90°C . For working-up, the reaction mixture is added to semi-saturated sodium bicarbonate solution, extracted 3 times with methylene chloride, washed with common salt solution, dried on magnesium sulfate and concentrated by evaporation in a vacuum. Chromatography of the crude product on silica gel with a methylene chloride-methanol gradient yields 229 mg of 11 β -fluoro-7 α -{5-{[N-3-(furan-2-ylmethylthio)-propyl]-N-methyl-amino}-pentyl)-3-hydroxy-estra-1,3,5(10)-trien-17-one as a foam.

f) 11 β -Fluoro-7 α -(5-{[N-3-(furan-2-ylmethylthio)-propyl]-N-methyl-amino}-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol

217 mg of 11 β -fluoro-7 α -(5-{[N-3-(furan-2-ylmethylthio)-propyl]-N-methyl-amino}-pentyl)-3-hydroxy-estra-1,3,5(10)-trien-17-one is dissolved in 6 ml of methanol and mixed in portions with 44 mg of sodium borohydride. After 1 hour of stirring at room temperature, the solvent is drawn off in a vacuum, the residue is mixed with common salt solution, extracted 3 times with methylene chloride, dried on magnesium sulfate and concentrated by evaporation in a vacuum. Preparative column chromatography with a methylene chloride/methanol gradient provides 146 mg of 11 β -fluoro-7 α -(5-{[N-3-(furan-2-ylmethylthio)-propyl]-N-methyl-amino}-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol as a foam.

Example 44

11 β -Fluoro-7 α -(5-{N-methyl-[N-3-(thiophen-2-ylmethylthio)-propyl]-amino}-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol

a) 11 β -Fluoro-3-hydroxy-7 α -(5-{N-methyl-[N-3-(thiophen-2-ylmethylthio)-propyl]-amino}-pentyl)-estra-1,3,5(10)-trien-17-one

526 mg of 11 β -fluoro-3-hydroxy-7 α -[5-(methylanino)-pentyl]-estra-1,3,5(10)-trien-17-one and 103 mg of 2-(3-chloropropylthiomethyl)-thiophene are dissolved in 5 ml of ethyl methyl ketone, mixed with 112 mg of sodium iodide and 104 mg of potassium carbonate and stirred for 4.5 hours at a bath temperature of 90°C. For working-up, the reaction mixture is added to semi-saturated sodium bicarbonate solution, extracted 3

times with methylene chloride, washed with common salt solution, dried on magnesium sulfate and concentrated by evaporation in a vacuum. Chromatography of the crude product on silica gel with a methylene chloride-methanol gradient yields 191 mg of 11 β -fluoro-3-hydroxy-7 α -(5-{N-methyl-[N-3-(thiophen-2-ylmethylthio)-propyl]-amino}-pentyl)-estra-1,3,5(10)-trien-17-one as a foam.

b) 11 β -Fluoro-7 α -(5-{N-methyl-[N-3-(thiophen-2-ylmethylthio)-propyl]-amino}-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol

185 mg of 11 β -fluoro-3-hydroxy-7 α -(5-{N-methyl-[N-3-(thiophen-2-ylmethylthio)-propyl]-amino}-pentyl)-estra-1,3,5(10)-trien-17-one is dissolved in 5 ml of methanol and mixed in portions with 28 mg of sodium borohydride. After 45 minutes of stirring at room temperature, the solvent is drawn off for the most part in a vacuum, the residue is added to common salt solution, extracted 3 times with methylene chloride, dried on magnesium sulfate and concentrated by evaporation in a vacuum. Preparative column chromatography with a methylene chloride/methanol gradient provides 93 mg of 11 β -fluoro-7 α -(5-{N-methyl-[N-3-(thiophen-2-ylmethylthio)-propyl]-amino}-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol as a foam.

Example 45

11 β -Fluoro-7 α -{5-[(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

a) 11 β -Fluoro-3-hydroxy-7 α -{5-[(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one

A solution of 0.5 g of 7 α -(5-chloropentyl)-11 β -fluoro-3-hydroxy-estra-1,3,5(10)-trien-17-one in 4 ml of dimethylformamide is stirred with 0.55 g of (2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidine and 0.32 g of lithium iodide for 2 hours at a bath temperature of 100°C. Then, it is added to sodium bicarbonate solution, extracted three times with ethyl acetate, washed with common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/acetone. 0.45 g of 11 β -fluoro-3-hydroxy-7 α -{5-[(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one with $[\alpha]_D^{22} = +32.7^\circ$ (c = 0.51% in chloroform) is obtained.

b) 11 β -Fluoro-7 α -{5-[(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 0.43 g of 11 β -fluoro-3-hydroxy-7 α -{5-[(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-trien-17-one in 4 ml of tetrahydrofuran, 2.3 ml of ethanol and 1 ml of water is mixed in portions at 0°C with 111 mg of sodium borohydride, and it is stirred for 2 hours. Then,

it is added to ice water, extracted three times with ethyl acetate, washed with common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/acetone. 0.32 g of 11 β -fluoro-7 α -{5-[(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol with $[\alpha]_D^{22} = +16.2^\circ$ (c = 0.51% in methanol) is obtained.

Example 46

11 β -Fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 0.2 g of 11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol in 5.8 ml of methanol and 2.9 ml of water is stirred with 82 mg of sodium periodate for 5 hours at room temperature. Then, it is added to water, extracted three times with dichloromethane, washed neutral, dried on sodium sulfate and concentrated by evaporation in a vacuum. 210 mg of crude product, which is chromatographed on silica gel with dichloromethane/methanol, is obtained. 105 mg of pure 14,17-ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol IR 1610 and 1190 [cm⁻¹] is obtained.

Example 47

11 β -Fluoro-17 α -methyl-7 α -{5-[(2R)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

Analogously to Example 29, 11 β -fluoro-17 α -methyl-7 α -{5-[(2R)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol with $[\alpha]_D^{22} = +68.7^\circ$ (c = 0.74% in chloroform) is obtained.

Example 48

11 β -Fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 100 mg of 3,17 β -diacetoxy-11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene in 1.3 ml of 0.2 M methanolic potassium hydroxide solution is stirred for 2 hours at room temperature. Then, it is added to water, extracted three times with dichloromethane, washed with common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/acetone. 63 mg of 11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained.

IR: 1710, 1660, 1610 [cm⁻¹].

Example 49

11 β -Fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

A solution of 300 mg of 11 β -fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol in 4.3 ml of methanol and 2.1 ml of water is stirred with 131 mg of sodium periodate for 4 hours at room temperature. Then, it is added to water, extracted three times with ethyl acetate, washed with common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/ethyl acetate. 203 mg of 11 β -fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained. $[\alpha]_D^{22} = +11.8^\circ$ (c = 0.53% in methanol).

Example 50

11 β -Fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

Analogously to what is described in Example 48, 11 β -fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol is obtained. $[\alpha]_D^{22} = +30.6^\circ$ (c = 0.515% in methanol).

Production of the Starting Compounds:**N-Methyl-[3-(4,4,5,5,5-pentafluoropentylthio)-propyl]-amine****a) 3-Iodopropyl-4,4,5,5,5-pentafluoropentylsulfide**

A solution of 22.8 g of 3-chloropropyl-4,4,5,5,5-pentafluoropentylsulfide in 500 ml of ethyl methyl ketone is stirred with 40 g of sodium iodide for 5 hours at a bath temperature of 100°C under nitrogen. Then, it is evaporated to the dry state in a vacuum, added to water, extracted three times with ethyl acetate, washed neutral, and dried on sodium sulfate and concentrated by evaporation in a vacuum. 30.6 g of 3-iodopropyl-4,4,5,5,5-pentafluoropentylsulfide is obtained.

b) N-Methyl-[3-(4,4,5,5,5-pentafluoropentylthio)-propyl]-amine

In a solution of 30.6 g of 3-iodopropyl-4,4,5,5,5-pentafluoropentylsulfide in 200 ml of absolute tetrahydrofuran, 45 g of methylamine is condensed at a bath temperature of -78°C, and it is stirred for 1.5 hours at room temperature and for 4 hours at 60°C in the pressurized reactor. To open the reactor, it is allowed to cool overnight to room temperature and then to -78°C. Then, it is allowed to come to room temperature, excess methylamine is evaporated, diluted with ethyl acetate, washed neutral, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 15.7 g of N-methyl-[3-(4,4,5,5,5-pentafluoropentylthio)-propyl]-amine is obtained as an oil.

N-Methyl-[3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propyl]-amine**a) 3-Chloropropyl-4,4,5,5,5-pentafluoropentanesulfone**

A solution of 23 g of 3-chloropropyl-4,4,5,5,5-pentafluoropentylsulfide in 230 ml of chloroform is mixed in portions at 0°C with 41.8 g of 70% m-chloroperbenzoic acid, and it is stirred for 1.5 hours at room temperature. Then, it is diluted with dichloromethane, washed with sodium hydrogen sulfite solution, sodium bicarbonate solution and common salt solution, dried on sodium sulfate and concentrated by evaporation in a vacuum. 23.8 g of pure 3-chloropropyl-4,4,5,5,5-pentafluoropentanesulfone is obtained as crystals with a melting point of 74-76°C.

b) 3-Iodopropyl-4,4,5,5,5-pentafluoropentanesulfone

A solution of 23.5 g of 3-chloropropyl-4,4,5,5,5-pentafluoropentanesulfone in 500 ml of ethyl methyl ketone is stirred with 40 g of sodium iodide for 5 hours at a bath temperature of 100°C under nitrogen. Then, it is evaporated to the dry state in a vacuum, added to water, extracted three times with ethyl acetate, washed neutral, and dried on sodium sulfate and concentrated by evaporation in a vacuum. 30.6 g of 3-iodopropyl-4,4,5,5,5-pentafluoropentanesulfone is obtained as crystals with a melting point of 88-89°C.

c) N-Methyl-[3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propyl]-amine

A solution of 23.5 g of 3-iodopropyl-4,4,5,5,5-pentafluoropentanesulfone in 200 ml of absolute tetrahydrofuran is condensed at a bath temperature of -78°C , 44 g of methylamine, and it is stirred for 1.5 hours at room temperature and for 4 hours at 60°C in a pressurized reactor. To open the reactor, it is allowed to cool overnight to room temperature and then to -78°C . Then, it is allowed to come to room temperature, excess methylamine is evaporated, diluted with ethyl acetate, washed neutral, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with dichloromethane/methanol. 14.8 g of N-methyl-[3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propyl]-amine is obtained as crystals with a melting point of $55-57^{\circ}\text{C}$.

1-Bromo-5-tert-butyldimethylsilyloxypentane

a) 5-Bromo-1-pentanol

50 ml of concentrated sulfuric acid is added in drops to a solution of 50 g of 5-bromopentyl acetate in 1.6 l of methanol, and the mixture is stirred for 30 hours at room temperature. The methanol is drawn off in a vacuum, the residue is taken up in diethyl ether, washed neutral with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation. 28 g of 5-bromo-1-pentanol is obtained as a crude product.

b) 1-Bromo-5-tert-butyldimethylsilyloxypentane

A solution of 28 g of crude 5-bromo-1-pentanol in 144 ml of tetrahydrofuran is mixed with 24 g of imidazole. Then, a solution of 30.3 g of *tert*-butyldimethylchlorosilane in 46 ml of tetrahydrofuran is added in drops, and it is stirred for 4 hours at room temperature. The reaction mixture is poured into water, shaken out with diethyl ether, the organic phase is washed 4 times with water, dried on sodium sulfate and concentrated by evaporation. The crude product is chromatographed on silica gel with hexane/diethyl ether. 42 g of the title compound is obtained as a colorless liquid.

(2S)-2-(4,4,5,5,5-Pentafluoropentylthiomethyl)-pyrrolidine**a) N-tert-Butyloxycarbonyl-L-prolinol-p-tosylate**

24.2 g of *p*-toluenesulfonic acid anhydride is added in portions to a solution of 10 g of *N*-*tert*-butyloxycarbonyl-L-prolinol in 170 ml of pyridine at 0°C, and the mixture is stirred for 5 hours at 0°C. The reaction mixture is poured onto 2N hydrochloric acid, extracted with ethyl acetate, the organic phase is washed with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation. 17.7 g of *N*-*tert*-butyloxycarbonyl-L-prolinol-p-tosylate is obtained as an oily crude product. $[\alpha]_D^{22} = -28.0^\circ$ ($c = 0.545$ in chloroform).

b) N-tert-Butyloxycarbonyl-(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidine

A solution of 3.93 g of 4,4,5,5,5-pentafluoropentylthioacetate in 18 ml of methanol is mixed with 2.94 ml of a sodium methanolate solution (30% in methanol), and it is stirred for 30 minutes at room temperature. This reaction solution is added to a solution of 3.0 g of N-tert-butyloxycarbonyl-L-prolinol-p-tosylate, and the mixture is stirred for 3 hours at room temperature and for 3 hours at 50°C. The reaction mixture is poured into water, extracted with ethyl acetate, washed with saturated sodium chloride solution, dried on sodium sulfate and concentrated by evaporation. The residue is chromatographed on silica gel with hexane/ethyl acetate. 2.59 g of N-tert-butyloxycarbonyl-(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidine is obtained as an oil. $[\alpha]_D^{22} = -41.3^\circ$ (c = 0.530 in chloroform).

c) (2S)-2-(4,4,5,5,5-Pentafluoropentylthiomethyl)-pyrrolidine

2.55 g of N-tert-butyloxycarbonyl-(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidine is added to 5.4 ml of trifluoroacetic acid, cooled to 0°C, and the mixture is stirred for 1.5 hours at 0°C and for 16 hours at room temperature. The reaction mixture is poured onto 10% sodium bicarbonate solution, extracted with ethyl acetate, washed with saturated common salt solution, dried on sodium sulfate and concentrated by evaporation. 1.8 g of the title compound is obtained as an oily crude product.

(2R)-2-(4,4,5,5,5-Pentafluoropentylthiomethyl)-pyrrolidine

Exactly as described in the production of (2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidine, 9.69 g of the title compound is obtained as an oily crude product from 10 g of N-*tert*-butoxy-carbonyl-D-prolinol.

(4,4,5,5,5-Pentafluoropentyl)-vinyl sulfone**a) (4,4,5,5,5-Pentafluoropentyl)-vinyl sulfide**

A solution of 40 g of 4,4,5,5,5-pentafluoropentylthioacetate in 200 ml of methanol is stirred with 34 ml of a 30% sodium methylate for 1 hour at 25°C, mixed drop by drop with 21 ml of 1,2-dibromoethane, stirred for another 2 hours at room temperature, mixed drop by drop with another 70 ml of 30% sodium methylate and stirred for 3 hours at 25°C. Then, methanol is concentrated by evaporation in a vacuum, added to water, extracted three times with ethyl acetate, washed with water and common salt solution, dried on sodium sulfate and concentrated by evaporation in a vacuum. 34 g of (4,4,5,5,5-pentafluoropentyl)-vinyl sulfide is obtained.

b) (4,4,5,5,5-Pentafluoropentyl)-vinyl sulfone

A solution of 34 g of (4,4,5,5,5-pentafluoropentyl)-vinyl sulfide in 74 ml of glacial acetic acid is mixed drop by drop with 59 ml of 30% hydrogen peroxide in such a way that the reaction temperature does not exceed 70°C. Then, it is stirred for one hour at a bath temperature of 70°C. Then, it is added to water, extracted three times with ethyl acetate, washed with

sodium thiosulfate, water and common salt solution, dried on sodium sulfate, concentrated by evaporation in a vacuum and chromatographed on silica gel with hexane/ethyl acetate. 12.3 g of (4,4,5,5,5-pentafluoropentyl)-vinyl sulfone is obtained as an oil.

2-(3-Chloro-propylthiomethyl)-furan

3.3 ml of a 30% sodium methylate solution in methanol is added in drops to 1.77 ml of furan-2-yl-methanethiol in 18 ml of anhydrous acetonitrile at 0°C. After 5 minutes, the drop-by-drop addition of 2.6 ml of 1-bromo-3-chloropropane is carried out. Then, the reaction solution is allowed to stir for 5 hours at room temperature. For working-up, the batch is diluted with ethyl acetate, washed with water and common salt solution, dried on magnesium sulfate and concentrated by evaporation in a vacuum. Chromatography of the crude product on silica gel with a hexane-ethyl acetate gradient yields 1.1 g of 2-(3-chloropropylthiomethyl)-furan as an oil.

2-(3-Chloro-propylthiomethyl)-thiophene

1.5 ml of a 30% sodium methylate solution in methanol is added in drops to 1.0 g of thiophen-2-yl-methanethiol in 8 ml of anhydrous acetonitrile at 0°C. After 5 minutes, the drop-by-drop addition of 1.1 ml of 1-bromo-3-chloropropane is carried out. Then, the reaction solution is allowed to stir for 5 hours at room temperature. For working-up, the batch is diluted with ethyl acetate, washed with water and common salt solution, dried

on magnesium sulfate and concentrated by evaporation in a vacuum. Chromatography of the crude product on silica gel with a hexane-ethyl acetate gradient yields 1.3 g of 2-(3-chloropropylthiomethyl)-thiophene as an oil.

(2S)-2-(4-Trifluoromethylphenylthiomethyl)-pyrrolidine

a) N-tert-Butyloxycarbonyl-(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidine

A solution of 1.65 g of 4-trifluoromethylthiophenol in 18 ml of dimethylformamide is mixed with 3 g of cesium carbonate and 3 g of N-**tert**-butyloxycarbonyl-L-prolinol-p-tosylate, and it is stirred for 8 hours at room temperature. The reaction mixture is poured into water, extracted with ethyl acetate, washed with saturated sodium chloride solution, dried on sodium sulfate and concentrated by evaporation. The residue is chromatographed on silica gel with hexane/ethyl acetate. 2.59 g of N-**tert**-butyloxycarbonyl-(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidine is obtained as an oil.

b) (2S)-2-(4-Trifluoromethylphenylthiomethyl)-pyrrolidine

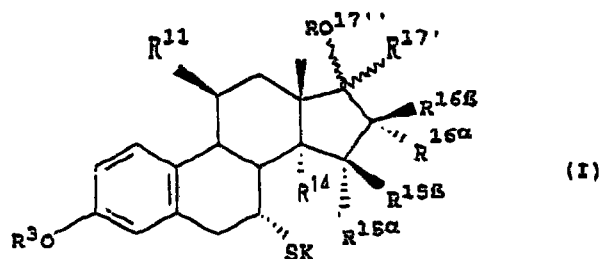
A solution of 2.55 g of N-**tert**-butyloxycarbonyl-(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidine in 5.64 ml of trifluoroacetic acid is stirred for 1 hour at 0°C and then for 3.5 hours at room temperature. The reaction mixture is poured onto 10% sodium bicarbonate solution, extracted with ethyl acetate, washed twice with 2 M hydrochloric acid, the water phase is extracted with ether, made basic with sodium bicarbonate,

extracted three times with ethyl acetate, washed with common salt solution, dried on sodium sulfate and concentrated by evaporation. 557 mg of (2S)-2-(4-trifluoromethylphenylthio-methyl)-pyrrolidine is obtained.



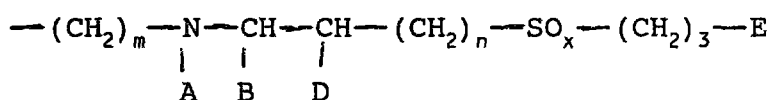
Claims

1. Substituted 7 α -(ξ -aminoalkyl)-estratrienes of general formula I



in which

side chain SK is a radical of partial formula



whereby m is 4, 5 or 6,

n is 0, 1 or 2,

x is 0, 1 or 2,

A is a hydrogen atom or a C_{1-5} alkyl group,

B and D each are a hydrogen atom, or

A and B together are an alkylene group $\text{---}(\text{CH}_2)_p\text{---}$ with

$p = 2, 3, 4$ or 5 , and D is a hydrogen atom or

A and D together are an alkylene group $\text{---}(\text{CH}_2)_q\text{---}$ with

$q = 2, 3$ or 4 , and B is a hydrogen atom, and

E is an unsubstituted ethyl radical or an ethyl radical that is fluorinated in one to five places, or terminal substituent $\text{---}(\text{CH}_2)_3\text{---E}$ in the side chain is replaced by an optionally substituted aryl or heteroaryl radical, which is bonded



directly or via a mono-, di- or trimethylene group to the sulfur atom,

R^3 is a hydrogen atom, a hydrocarbon radical with up to 8 carbon atoms or a radical of partial formula $R^{3'}-C(O)-$, in which $R^{3'}$ is a hydrogen atom or a hydrocarbon radical with up to 8 carbon atoms or a phenyl radical,

R^{11} is a hydrogen atom, a halogen atom or a nitrooxy group $-O-NO_2$,

R^{14} , $R^{15\alpha}$, $R^{15\beta}$, $R^{16\alpha}$ and $R^{16\beta}$ each are a hydrogen atom or R^{14} and $R^{15\alpha}$ are an additional bond or a methylene bridge, or $R^{15\beta}$ is a methyl group and $R^{15\alpha}$ is a hydrogen atom, or $R^{15\alpha}$ and $R^{15\beta}$ in each case are a methyl group, or $R^{15\beta}$ and $R^{16\beta}$ together are a methylene bridge, or $R^{16\alpha}$ or $R^{16\beta}$ is a halogen atom or $R^{16\alpha}$ and $R^{16\beta}$ together are a methylenidene group and the remaining substituents R^{14} , $R^{15\alpha}$, $R^{15\beta}$, $R^{16\alpha}$ and $R^{16\beta}$ are each a hydrogen atom,

$R^{17'}$ in α - or β -position is a hydrogen atom, a C_{1-5} alkyl, C_{2-5} alkenyl or C_{2-5} alkynyl group or a trifluoromethyl group and

$R^{17''}$ is a hydrogen atom or a radical of partial formula $R^{17'''}-C(O)-$, in which $R^{17'''}$ is a hydrogen atom or a hydrocarbon radical with up to 8 carbon atoms, or, if $R^{17'}$ is in α -position, $R^{17'}$ together with R^{14} means an ethano bridge,



provided that unless A and B together stand for $-(CH_2)_p-$ or A and D together stand for $-(CH_2)_q-$, at least one of substituents R^{11} , R^{14} , R^{15a} , R^{15b} , R^{16a} and R^{16b} is not a hydrogen atom, as well as their physiologically compatible addition salts with organic and inorganic acids.

2. Estratrienes according to claim 1, in which m is 5.
3. Estratrienes according to claim 1, in which n is 0.
4. Estratrienes according to claim 1, in which n is 1.
5. Estratrienes according to claim 1, in which n is 2.
6. Estratrienes according to claim 1, in which A is a methyl group.
7. Estratrienes according to claim 1, in which x is 0.
8. Estratrienes according to claim 1, in which x is 1.
9. Estratrienes according to claim 1, in which x is 2.
10. Estratrienes according to claim 6, in which n is 1.
11. Estratrienes according to claim 1, in which A and B together are $-(CH_2)_3-$.
12. Estratrienes according to claim 11, in which n is 0.
13. Estratrienes according to claim 12, in which x is 0.
14. Estratrienes according to claim 1, in which E is a perfluoroethyl radical.
15. Estratrienes according to claim 1, in which R^3 is a hydrogen atom.
16. Estratrienes according to claim 1, in which R^3 is a methyl group.
17. Estratrienes according to claim 1, in which R^3 is an acetyl group.



18. Estratrienes according to claim 1, in which R^{11} is a hydrogen atom.

19. Estratrienes according to claim 1, in which R^{11} is a fluorine atom.

20. Estratrienes according to claim 1, in which R^{11} is a nitrooxy group.

21. Estratrienes according to claim 1, in which R^{14} is a hydrogen atom.

22. Estratrienes according to claim 1, in which R^{14} together with R^{15a} forms an additional bond.

23. Estratrienes according to claim 1, in which R^{15b} is a methyl group.

24. Estratrienes according to claim 1, in which R^{15b} and R^{16b} together form a methylene bridge.

25. Estratrienes according to claim 1, in which R^{16a} is a halogen atom (F, Cl, Br, I).

26. Estratrienes according to claim 25, in which R^{16a} is a fluorine atom.

27. Estratrienes according to claim 1, in which R^{16a} and R^{16b} together form a methyldene group.

28. Estratrienes according to claim 1, in which R^{17} is in α -position.

29. Estratrienes according to claim 28, in which R^{17} is a trifluoromethyl group.

30. Estratrienes according to claim 28, in which R^{17} is a methyl group.



31. Estratrienes according to claim 28, in which R^{17} is a hydrogen atom.
32. Estratrienes according to claim 1, in which R^{17} is in β -position.
33. Estratrienes according to claim 32, in which R^{17} is a methyl group.
34. Estratrienes according to claim 32, in which R^{17} is a hydrogen atom.
35. Estratrienes according to claim 28, in which R^{14} and R^{17} together form an ethano bridge.
36. Estratrienes according to claim 1, in which SK is a radical of partial formula
- $$\begin{array}{c} \text{---}(\text{CH}_2)_5\text{---N---}(\text{CH}_2)_3\text{---SO}_x\text{---}(\text{CH}_2)_3\text{---C}_2\text{F}_5 \text{ with } x = 0, 1 \text{ or } 2. \\ | \\ \text{CH}_3 \end{array}$$
37. Estratrienes according to claim 13, in which $m = 5$, E is a perfluoroethyl radical and the conformation of the 2-carbon atom of the heterocycle is R.
38. Estratrienes according to claim 13, in which $m = 5$, E is a perfluoroethyl radical and the conformation of the 2-carbon atom of the heterocycle is S.
39. Estratrienes according to claim 37, in which R^{17} is in α -position and is a hydrogen atom.
40. Estratrienes according to claim 1, namely
- 14,17-Ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol



14,17-ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

3,17 β -diacetoxy-14 α ,17 α -ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene

14,17-ethano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

17 α -trifluoromethyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β ,16 β -methano-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β ,16 β -methano-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β ,16 β -methano-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

15 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoro-pentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol



15 β ,17 α -dimethyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-17 β -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 α -diol

16 α -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol



16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 α -diol

16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

16 α -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol

7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol

7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10),14-tetraene-3,17 β -diol

7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

7 α -{5-[(2R)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

17 α -methyl-7 α -{5-[2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -nitrooxy-7 α -(9-[4,4,5,5,5-pentafluoropentanesulfonyl]-nonyl)-estra-1,3,5(10)-triene-3,17 β -diol



11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfonyl)-propylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[N-methyl-N-2-(4,4,5,5,5-pentafluoropentanesulfonyl)-ethylamino]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol



11 β -fluoro-7 α -{5-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-pentyl}-3-hydroxy-estra-1,3,5(10)-trien-17-one

11 β -fluoro-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentylthio)-propylamino]-hexyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{6-[N-methyl-N-3-(4,4,5,5,5-pentafluoropentanesulfinyl)-propylamino]-hexyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -(5-{[N-3-(furan-2-ylmethylthio)-propyl]-N-methyl-amino}-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -(5-{N-methyl-[N-3-(thiophen-2-ylmethylthio)-propyl]-amino}-pentyl)-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[(2S)-2-(4-trifluoromethylphenylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-17 α -methyl-7 α -{5-[(2R)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentylthiomethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfinylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol

11 β -fluoro-7 α -{5-[(2S)-2-(4,4,5,5,5-pentafluoropentanesulfonylmethyl)-pyrrolidin-1-yl]-pentyl}-estra-1,3,5(10)-triene-3,17 β -diol.

41. Pharmaceutical preparations that contain at least one compound of general formula I according to claim 1 as well as a pharmaceutically compatible vehicle.

42. Use of the compounds of general formula I according to claim 1 for the production of pharmaceutical agents.

