Synthesis of Cycloalkanoindoles by an Unusual DAST-Triggered Rearrangement Reaction

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A series of 1,1-bis(indol-3-yl) and 1-(indol-2-yl)-1-(indol-3-yl)-ω-hydroxyalkanes, prepared from the corresponding indole derivatives and suitable hydroxyaldehydes via routine coupling reactions, were treated with DAST (diethylaminosulfur trifluoride) under mild conditions, to generate a small library of cycloalkanoindoles. Irrespective of the substitution pattern, i.e. whether they are symmetrical or unsymmetrical derivatives, the same mixture of products is produced, in which the tetrahydro-1*H*-carbazole and hexahydrocyclohepta[*b*]indole scaffolds are substituted by a indol-3-yl nucleus on one of the two α-carbon atoms of the cycloalkane moieties. Thus, speculations on the reaction mechanism with the prediction of a common reaction intermediate are presented.

Introduction

In the last few decades, compounds containing a perhydrocycloalkano[*b*]indole structure have been synthesized and studied with the aim of exploring their possible therapeutic activity. Besides having the same 3-substituted indole nucleus as such fundamental biomolecules as tryptophan and melatonin, they also possess a molecular framework closely related to that of many biologically active, naturally occurring carbazole alkaloids. A series of aminotetrahydrocarbazole derivatives was found to act on the central nervous system.[1] Cycloalkanoindoles have been studied for their anti-inflammatory,[2] antidepressant[3] and analgesic properties.[4−7] Antibacterial activity has been recognized in a number of substituted tetrahydrocarbazoles,[8] while some antitumor alkaloids, such as staurosporine, K-252a, and rebeccamycin, possess a cycloalkanoindole structure.[9] Some pyridiniotetrahydrocarbazoles and bis(indol-3-yl) derivatives have been studied for their antiproliferative[10] and cytodifferentiating properties, respectively.[11]

As a part of a medicinal chemistry program whose aim is the design of angiogenesis inhibitors, we have been involved in the synthesis of substituted cycloalkanoindoles. Several approaches are known for the synthesis of cycloalkanoindoles, for example, tetrahydrocarbazoles and hexahydrocyclohept[*b*]indole derivatives, but most of them require multiple steps, and generally give low overall yields. During our earlier research[12] aimed at the synthesis of 1,1-bis(indol-3-yl)alkanes functionalized at the level of the alkyl chain, we found that the 1,1-bis(indolyl)-ω-hydroxyalkyl derivatives **1** and **2**, when treated with DAST (diethylaminosulfur trifluoride), afforded the indolyl-substituted cyloalkanoindole structural isomers **5** and **6** as the major products (Figure 1 and Scheme 1).[13] It is worth noting that **5** and **6** are both formed, irrespective of which bis(indolyl)alkane (i.e. the 3,3′-isomer **1** or the 2,3′-isomer **2**) is used as the starting material. This allows us to think of the reaction mechanism as a DAST-mediated molecular rearrangement.[14] The expected 1,1-bis(indolyl)-ω-fluoroalkyl derivatives **3** and **4** were also formed, but in lower yields. In this paper, we wish to present full details of the synthesis of substituted cycloalkanoindoles starting from 1,1-bis(indol-3-yl)alkanes, as well as their structural characterization; also speculations on the reaction mechanism will be proposed to a certain extent.

Results and Discussion

The proposed starting materials for the synthesis of indolyl(cycloalkanoindoles) were ω-functionalized 1,1-bis(indol-3-yl)- and 1-(indol-2-yl)-1-(indol-3-yl)alkanes; the key step in the synthesis being an annulation reaction trig-

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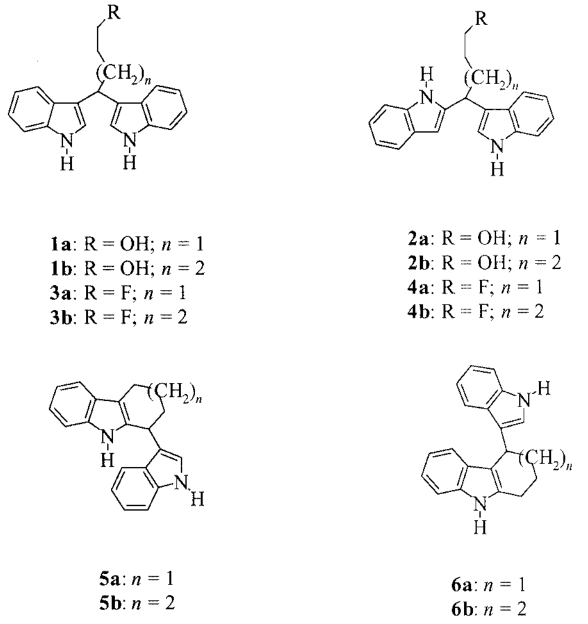


Figure 1. Bis(indolyl)alkanes and cycloalkanoindoles: reference structures

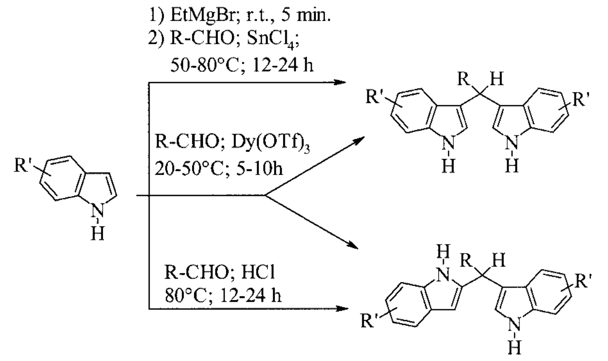
$$\textbf{1a,b} \xrightarrow{\text{DAST}} \textbf{(3a,b)} + \textbf{5a,b} + \textbf{6a,b}$$

$$\textbf{2a,b} \xrightarrow{\text{DAST}} \textbf{(4a,b)} + \textbf{5a,b} + \textbf{6a,b}$$

Scheme 1. New DAST-triggered ring-closure reaction of bis(indolyl)alkanes; the 1,1-bis(indolyl)-ω-fluoroalkyl derivatives **3** and **4** are formed as by-products

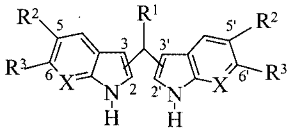
gered by the creation of an electrophilic site at the carbon of the alkyl chain. This reaction occurred as expected when we treated the 1,1-bis(indolyl)-ω-hydroxyalkanes **1** and **2** with DAST.

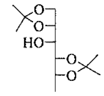
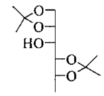
With the aim of synthesizing a small library of bis(indolyl)alkane derivatives (Scheme 2; Table 1), with selected substituents on the indole nucleus and a hydroxy functionality on the alkyl chain, we employed three different synthetic procedures, all of them making use of masked hydroxyaldehydes as precursors of the electrophile. With poorly reactive aldehydes like protected sugars (i.e. mannofuranose), the indole derivative was activated as its magnesium salt; $SnCl_4$ was used as the catalyst[15−18]. In this case, only the symmetrical 1,1-bis(indol-3-yl)hydroxyalkyl derivatives were produced (procedure A). For unsubstituted linear hydroxyaldehydes, used in their furanose or pyranose forms, the reactions were catalyzed by dysprosium triflate [$Dy(OTf)_3$][19] or HCl (procedures B1 and B3).[20,21] The catalyst used influences the ratio of symmetrical and unsymmetrical products, irrespective of the aldehyde substrate. In the presence of HCl, the unsymmetrical product becomes predominant. It should be considered that in the case of the 5,6-(methylenedioxy)indole, when the condensation reaction with 2-ethoxytetrahydrofuran is carried out at 70 °C in the presence of $Dy(OTf)_3$ (procedure B2), the 1,1-bis(indol-2-yl)hydroxyalkyl derivative is also formed (15−20%).



Scheme 2. Synthetic strategies for the preparation of geminal bis(indolyl)hydroxyalkyl derivatives (only main products are reported)

Table 1. Bis(indolyl)hydroxyalkyl derivatives



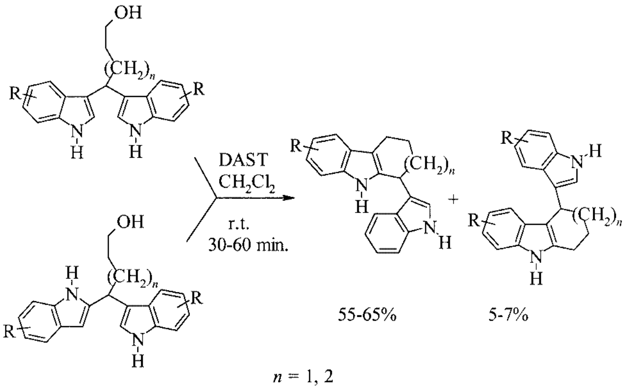
	Procedure	Yield (%)	s.p.[a]	X	R1	R2	R3
1a	B1	42	3,3'	CH	$-(CH_2)_3-OH$	H	H
1b	B1	40	3,3'	CH	$-(CH_2)_4-OH$	H	H
2b	B2	45	2,3'	CH	$-(CH_2)_4-OH$	H	H
3b	B1	12	3,3'	CH	$-(CH_2)_4-F$	H	H
4b	B1	11	2,3'	CH	$-(CH_2)_4-F$	H	H
7	A	55	3,3'	CH		H	H
8	A	22	3,3'	N		H	H
9	B1	40	3,3'	CH	$-(CH_2)_4-OH$	O-CH2-Ph	H
10	A	13	3,3'	N	$-(CH_2)_3-OH$	H	H
11a	B1	23	3,3'	CH	$-(CH_2)_4-OH$	$-O-CH_2-O-$	
11b	B2	24	2,3'	CH	$-(CH_2)_4-OH$	$-O-CH_2-O-$	
12a	B1	35	3,3'	CH	$-(CH_2)_3-OH$	$-O-CH_2-O-$	
12b	B2	26	2,3'	CH	$-(CH_2)_3-OH$	$-O-CH_2-O-$	
13[b]	B2	15	2,2'	CH	$-(CH_2)_3-OH$	$-O-CH_2-O-$	

[a] s.p.: substitution pattern of indoles. [b] Reaction temperature 70 °C.

In a first attempt to explain the reaction mechanism, it is conceivable that an initial electrophilic attack of the activated carbonylic carbon takes place at positions 3 (preferred) or 2 of the indole nucleus. The electrophilic attack, promoted by the Lewis or protic acid, of the monoalkylindolyl derivative at another indole molecule, is supposed also to operate in the second step of the overall reaction, leading to the bis(indolyl) derivative. However, in order to gain further insight into the reaction mechanism, the symmetrical bis(indolyl) derivative **12a** was submitted to the reaction conditions (HCl at 80 °C) that generally produce higher yields of the unsymmetrical product in the condensation reaction. Quite surprisingly, the substrate rearranged by forming an almost equimolar mixture of the two regioisomers. It should be concluded that, at least in some cases, a more complicated reaction mechanism must be considered, in which a common initially formed intermediate can lead, reversibly, to both reaction products. If this is the case, then the 1-(indol-2-yl)-1-(indol-3-yl) derivatives, or even the 2,2′-isomers, could be formed through a concomitant 1,2-hydride shift from C-2 of the indole nucleus at the level of the putative intermediate itself. It is also worth noting that the 2,3′-isomers are stable under reaction conditions that favor isomerization; this is in agreement with the hypothesis that they are the more stable regioisomers formed in the condensation reactions.

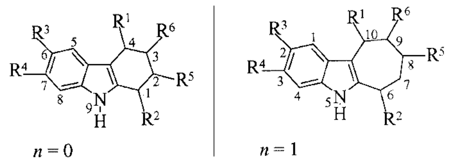
In the literature, cases are described that support both the possible reaction mechanisms, i.e. the direct electrophilic attack at C-2 and the group rearrangement at C-2 after the initial attack at C-3. For the former case, it is reported that strong electrophiles prefer to perform the substitution reaction at the 2-position on 3-alkylindoles.[22,23] On the other hand, both the Pictet−Spengler type cyclization to form tetrahydro-β-carbolines[24] and the Plancher rearrangement of 3,3-dialkyl-3*H*-indolinium ions to give 2,3-dialkylindoles are believed to occur through migration of an alkyl moiety at the level of an indoline intermediate.[25,26] Also, tetrahydrocarbazoles are reported to rearrange to 2,2-spirocycloalkyl-3-oxoindole derivatives under photo-oxygenation conditions.[27]

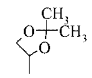
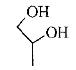
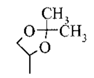
All the 1,1-bis(indol-3-yl)- and the 1-(indol-2-yl)-1-(indol-3-yl)hydroxyalkyl derivatives listed in Table 1 were treated with DAST, in dichloromethane at room temperature. As observed above, besides the anticipated bis(indolyl)-fluorinated products **3** and **4**, the indolyl-substituted 2,3,4,9-tetrahydro-1*H*-carbazoles **5a** and **6a** and the indolyl-substituted 5,6,7,8,9,10-hexahydrocyclohepta[*b*]indole derivatives **5b** and **6b** were unexpectedly formed from **1a**−**2a** and **1b**−**2b**, respectively, in quite excellent yields (see Figure 1 and Scheme 1). A general scheme of the cyclization reaction is shown in Scheme 3; a full list of the reaction products and conditions is reported in Table 2. For the reaction of **7**, the 2,3,4,9-tetrahydro-1*H*-carbazole derivative **14** was formed as the only product (Scheme 4). The protected derivatives **14** and **17**, were deprotected following standard procedures. Partial deprotection of **14** was also carried out under mild conditions, giving rise to the monoacetonide derivative **22**.



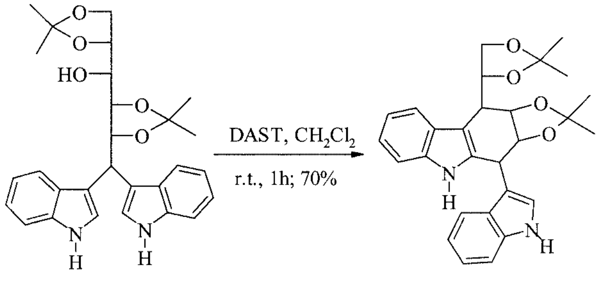
Scheme 3. Cyclization reaction of bis(indolyl) derivatives

Table 2. 2,3,4,9-Tetrahydro-1*H*-carbazoles (n = 0) and 5,6,7,8,9,10-hexahydrocyclohepta[*b*]indoles (n = 1)



	Starting material	Via	Yield %	n	R^1	R^2	R^3	R^4	R^5	R^6
5a	**1a**	C	64	0	indol-3-yl	H	H	H	H	H
5b	**1b** **2b**	C	65	1	indol-3-yl	H	H	H	H	H
6a	**1a**	C	7	0	H	indol-3-yl	H	H	H	H
6b	**1b** **2b**	C	6	1	H	indol-3-yl	H	H	H	H
14	**7**	C	70	0	indol-3-yl		H	H	O-C(CH_3)$_2$-O	
15	**11a** **11b**	C	55	1	5,6-methylene-dioxyindol-3-yl	H	O-CH_2-O		H	H
16	**12a** **12b**	C	58	0	5,6-methylene-dioxyindol-3-yl	H	O-CH_2-O		H	H
17	**9**	C	62	1	5-BnO-indol-3-yl	H	O-Bn	H	H	H
18	**12a** **12b**	C	5	0	H	5,6-methylene-dioxyindol-3-yl	O-CH_2-O		H	H
19	**9**	C	5	1	H	5-BnO-indol-3yl	O-Bn	H	H	H
20	**19**	D	85	1	5-OH-indol-3-yl	H	OH	H	H	H
21	**14** **22**	E	>98	0	indol-3-yl		H	H	OH	OH
22	**14**	E	30	0	indol-3-yl		H	H	OH	OH

All the cycloalkanoindoles were characterized by ^1H NOESY and/or $^1H,^{13}C$-HMBC. Diagnostic proton−carbon connectivities were detected between the proton on the nitrogen and the nuclei α to C-2 of the indole ring. In particular, a strong NOE between N-5−H and the methyne proton was detected for **5b**, while a strong NOE was ob-



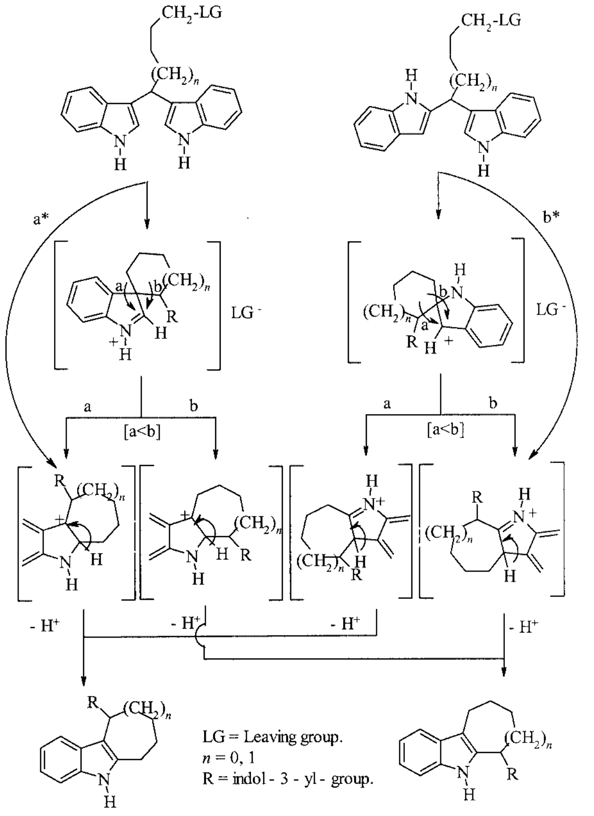
7 **14**

Scheme 4. Cyclization reaction of mannofuranose derivatives

served between N-5−H and the methylene protons at C-6 in **6b**. The structural assignment was also confirmed for **5b** using ^1H ^{13}C-HMBC; the diagnostic proton−carbon connectivity between N-5−H and C-6 was detected (see heading of Table 2 for sites numbering).

As already observed, the indolyl-substituted cyclized products are formed as a mixture of two components, with the indol-3-yl substituent at C-1 or C-4 (C-6 or C-10) of the tetrahydrocyclohexane (hexahydrocycloheptane) ring cumulated to the indole nucleus (it is important to note that the indol-2-yl moiety, when present in the starting material, is not conserved in the end products). These two product types are formed in the same amounts, irrespective of which compound, be it the symmetrical 1,1-bis(indol-3-yl)- or unsymmetrical 1-(indol-2-yl)-1-(indol-3-yl) derivative, is used as the starting material. Generally, the predominant isomer is the one carrying the indol-3-yl substituent at C-1 (tetrahydro-1*H*-carbazoles) or C-6 (hexahydrocyclohepta[*b*]indoles).

These results indicate that the two reaction pathways, starting from the two different bis(indolyl) regioisomers, must share common intermediates, which lead to the final mixture of products. It is worth mentioning that a DAST-mediated rearrangement reaction of the indole nucleus that goes via a spiro intermediate was recently thoroughly investigated by D. J. Hallett, U. Gerhard and co-workers,[14] while our chemical and pharmaceutical studies were already in progress.[12,13] It is conceivable that also in our case, the key step is the formation of a reactive electrophilic site on the alkyl chain, and that this intramolecularly attacks one of the two indole nuclei. A possible reaction mechanism, which can account for the observed results, is shown in Scheme 5 (the indol-3-yl moiety is represented by "R" in the starting materials in the cases where it does not directly participate in the reaction). The reaction of the hydroxy group in the substrates with DAST creates a good leaving group (LG), thus commencing the reaction sequence of electrophilic annulation, with the formation of spiro-intermediates on C-3 or C-2 from symmetrical and unsymmetrical bis(indolyl) derivatives, respectively. Both the spiro-intermediates then undergo ring-enlargement through bond shifts, either via pathway "*a*" or "*b*", giving rise to the intermediate structures reported at the third level of Scheme 5. These cations are finally stabilized by loss of a proton from C-2 and C-3 of the indole nuclei. It should be emphasized that in both cases, pathway "*b*" appears to be preferred, as seen in the predominance of the products arising from this route.



Scheme 5. Hypothetical mechanism for the ring-closure reaction. The direct electrophilic attack at C-2 (a*) and C-3 (b*) are also conceivable processes, leading to their respective products

Conclusions

In summary, we have developed a two-step, high-yielding synthetic strategy for the preparation of indolyl(cycloalkanoindoles), such as tetrahydro-1*H*-carbazole and hexahydrocyclohept[*b*]indole derivatives, containing a second aromatic base (the indole itself or one of its derivatives) as a substituent on one of the two α-positions of the cycloalkane moiety. These cycloalkanoindole derivatives represent very interesting molecular scaffolds in medicinal chemistry, because of the antiangiogenic and antitumour properties of some members of the series. It is also worth noting that ours is the second example of indole-substituted carbazole derivatives present in the literature, the first very old one appeared in the mid-seventies, and describes an indolyltetrahydrocarbazolecarboxylic acid, produced by pyrolysis from a sponge tryptophan metabolite (hypaphorine).[28]

Biology

Both geminal bis(indolyl) and cycloalkanoindole compounds were tested for enhancement of the cytodifferentiating properties of retinoid in myeloid leukemia cells. **1a** and **1b** showed interesting cytotoxic and cell growth inhibition properties.[11] Most cycloalkanoindole derivatives also behave as antiangiogenic and cytotoxic agents[13] (cell cycle, apoptosis analysis on tumor cell lines and activity data on tumor-resistant cell lines are also reported). In particular, with reference to the antiangiogenic activity, the chemotactic assay with the Boyden chamber was performed using both bovine aortal endothelial cell (BAEC) cultures and bovine medullary endothelial cell (BMEC) cultures. The most active compound was **5b**, with about 60% of inhibition of migration across a porous filter, in response to a chemotactic stimulus. For the cytotoxic activity, proliferation screening tests were used, with different tumor lines such as MCF-7 (human mammary carcinoma), LoVo (human colon carcinoma), MES-SA (human uterine sarcoma) and K-562 (human chronic myeloid leukemia). For all the compounds, the range of activity lies between 10−50 μM, with the exception of **18**, which showed sub-micromolar activity in different cell lines.

Experimental Section

General Remarks: All commercially available chemicals were used without further purification unless otherwise noted. Analytical thin layer chromatography (TLC) was performed using Merck silica gel $60F_{254}$ glass sheets, and spots were visualized using a UV lamp (254 nm), iodine and/or a phosphomolybdic acid solution (5% in ethanol). Flash column chromatography was performed using Merck silica Gel 60 (0.040−0.063 mm). High Pressure Liquid Chromatographic (HPLC) was performed using a JASCO Detector MD-910 and a JASCO Pump PU-980, with different columns as indicated in detail for each compound. Melting points were determined in open capillaries using a Buchi 530 apparatus and are uncorrected, or with a Mettler DSC-30/Mettler TG-50 apparatus. NMR spectra were recorded with Varian VXR-300s or Bruker Avance spectrometers at different frequencies (600 MHz, 500 MHz, 400 MHz or 300 MHz). Chemical shifts are given in ppm and are referenced to residual protonated solvent signals as internal standard. Coupling constants *J* are given in Hz and the following abbreviations are used: s: singlet, d: doublet, dd: doublet of doublet, t: triplet, m: multiplet. Mass spectra were obtained with Platform LC micromass spectrometer. Elemental analysis were determined with a Thermofinnigan EA1110 CHNS-O machine.

General Procedures for the Synthesis of Bis(indole) Derivatives

Procedure A: This methodology (Scheme 2) required the preparation of the indolylmagnesium bromide by the following procedure: Indole (2 mmol) or its derivative was added to an anhydrous diethyl ether solution of alkylmagnesium bromide (2 mmol) (prepared from the corresponding alkyl bromide (2 mmol) and magnesium (2 mmol) in an anhydrous solvent, i.e. diethyl ether or tetrahydrofuran), whilst stirring at room temperature. The solvent was removed under vacuum, and the crude residue was dissolved in an inert organic solvent, such as CH_2Cl_2 or $CHCl_2CHCl_2$. Next, the Lewis acid (i.e. $SnCl_4$, 2 mmol) and the aldehyde (i.e. 2,3,5,6-di-*O*-isopropylidene-D-mannofuranose, 1 mmol) were added. After stirring for 12−24 h at +50 °C to +80 °C, the reaction was quenched by addition of a saturated aqueous solution of $NaHCO_3$/10%NH_4Cl. The organic phase was washed with a small volume of water, dried with anhydrous $MgSO_4$, filtered and concentrated to dryness. The desired product was purified by flash chromatography (hexane/acetone).

Procedure B1: A different synthetic method (Scheme 2) was used for simple hydroxyaldehydes: the indole or its derivative (2 mmol) was dissolved, along with the aldehyde (5-hydroxypentanal or 2-ethoxytetrahydrofuran, 1 mmol), in 15 mL of $MeOH/H_2O$ (2:1). Then $Dy(OTf)_3$ (0.4 mmol) was added, and the mixture was reacted at 20−50 °C for 5−10 h. The reaction was quenched with 10% aqueous $NaHCO_3$, and extracted with CH_2Cl_2. The organic phase was dried with anhydrous Na_2SO_4, and the solvents were evaporated. The crude residue was purified by preparative-HPLC and the two regioisomers were isolated.

Procedure B2: (Same experimental conditions as B1, but at higher temperature, $T = 70$ °C): at this temperature, the unusual 2,2′-regioisomer **13** was isolated in a low yield (15−20%), using the 5,6-(methylenedioxy)indole as starting material.

Procedure B3: The following modified procedure (Scheme 2) was applied to increase the yield of the unsymmetrical 2,3′-regioisomer: the indole or its derivative (2.4 mmol) was dissolved in a mixture of CH_3OH (10 mL) and HCl (1 N, 5 mL). The hydroxyaldehyde derivative (1 mmol) was added and the resulting solution was warmed at 80 °C for 12−24 h. After this time, the methanol was removed under vacuum and the residue was extracted with CH_2Cl_2. The organic phase was washed with water, dried with anhydrous Na_2SO_4, filtered and concentrated to dryness. The crude residue was purified by flash chromatography, using a hexane/diethyl ether gradient, ranging from 9:1 to 7:3, as the eluent. The unsymmetrical 2,3′-regioisomers were isolated with high yields.

General Procedure for Synthesis of Cycloalkanoindole Derivatives

Procedure C: The symmetrical or unsymmetrical bis(indolyl) derivative (1 mmol) (Scheme 3) was dissolved in CH_2Cl_2 (80 mL), and diethylaminosulfur trifluoride (DAST) (400 μL, 3 mmol) was added (T = 0 °C − room temp.). The reaction was fast (after 15−20 min, almost complete conversion of the starting material was observed). After 30−60 min, a 10% aqueous solution of $NaHCO_3$ was added, and the reaction mixture was extracted with CH_2Cl_2. The organic phase was dried with anhydrous Na_2SO_4, and the solvents were evaporated. The products were isolated by preparative TLC or by preparative HPLC RP-18. The formation of both derivatives (Scheme 3) was observed, starting from both the symmetrical and the unsymmetrical bis(indolyl) derivatives (**5a**, **5b**: yield 55−70%; **6a**, **6b**: yield 5−7%).

Other General Procedures

Procedure D: The benzyloxy-substituted derivative **17** (1 mmol) was dissolved in CH_3OH (50 mL). After addition of the catalyst (10% Pd/C, 30 mg), the solution was left under hydrogen (60 psi) at room temperature. After 16 h, quantitative conversion of the starting material was observed, and the catalyst was filtered off. The organic phase was evaporated, and the deprotected product **20** was purified by flash chromatography (yield 85%).

Procedure E: The protected starting material **14** (1 mmol) was dissolved in tetrahydrofuran (50 mL) and HCl (1 N) was added. The reaction mixture was reacted for 1 h at room temperature. After addition of a saturated aqueous solution of $NaHCO_3$, the THF was evaporated, and the product was extracted with EtOAc. The organic phase was evaporated, and the deprotected product was purified by flash chromatography. **21** was isolated in quantitative yield.

To obtain a selective deprotection of the starting material, the acidic hydrolysis was performed at a lower temperature (e.g. HCl

1 N at 0 °C, for 30−60 min), obtaining **22** as the main product (yield: 30%).

Compound 1a: Yield 42%, 128 mg. Starting materials: indole and 2-methoxytetrahydrofuran; Procedure B1. TLC (hexane/EtOAc, 1:1; R_f = 0.26); HPLC RP-18 (Waters 300 × 3.9, 5 µm; H_2O/CH_3CN, 50:50, flow: 1 mL/min; room temp. 8.30 min). ^{1}H NMR (600 MHz, [D_3]CD_3CN): δ = 9.02 (br. s, 2 H, H-1′), 7.50 (d, *J* = 8.1 Hz, 2 H, H-4′), 7.35 (d, *J* = 8.1 Hz, 2 H, H-7′), 7.15 (d, *J* = 2.4 Hz, 2 H, H-2′), 7.05 (t, *J* = 8.1 Hz, 2 H, H-6′), 6.92 (t, *J* = 8.1 Hz, 2 H, H-5′), 4.45 (t, *J* = 7.7 Hz, 1 H, H-1), 3.54 (t, *J* = 6.5 Hz, 2 H, H-4), 2.50 (br. s, 1 H, 4-OH), 2.29−2.23 (m, 2 H, H-2), 1.59−1.52 (m, 2 H, H-3) ppm. ^{13}C NMR (75 MHz, [D_3]CD_3CN): δ = 137.9 (C-7′a), 128.1 (C-4′a), 122.8 (C-2′), 122.3 (C-6′), 120.7 (C-3′), 120.3 (C-4′), 119.5 (C-5′), 112.3 (C-7′), 62.8 (C-4), 34.7 (C-1), 35.6 (C-3), 32.5 (C-2) ppm. MS (IS): *m/z* = 303 $[M - H]^-$. $C_{20}H_{20}N_2O$ (304.39): calcd. C 78.92, H 6.62, N 9.20; found C 78.88, H 6.70, N 9.10. M.p. 110−115 °C.

Compound 1b: Yield 40%, 127 mg. Starting materials: indole and 5-hydroxypentanal; Procedure B1. TLC (hexane/EtOAc, 70:30; R_f = 0.27); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 40:60; flow:1 mL/min; room temp. 5.36 min). ^{1}H NMR (600 MHz, [D_3]CD_3CN): δ = 9.00 (br. s, 2 H, H-1′), 7.49 (d, *J* = 8.1 Hz, 2 H, H-4′), 7.34 (d, *J* = 8.1 Hz, 2 H, H-7′), 7.15 (d, *J* = 2.3 Hz, 2 H, H-2′), 7.05 (t, *J* = 8.1 Hz, 2 H, H-6′), 6.91 (t, *J* = 8.1 Hz, 2 H, H-5′), 4.44 (t, *J* = 7.7 Hz, 1 H, H-1), 3.45 (t, *J* = 6.6 Hz, 2 H, H-5), 2.39 (br. s, 1 H, 5-OH), 2.26−2.20 (m, 2 H, H-2), 1.58−1.51 (m, 2 H, H-4), 1.43−1.35 (m, 2 H, H-3) ppm. ^{13}C NMR (75 MHz, [D_3]CD_3CN): δ = 137.9 (C-7′a), 128.1 (C-4′a), 122.8 (C-2′), 122.2 (C-6′), 120.8 (C-3′), 120.2 (C-4′), 119.4 (C-5′), 112.3 (C-7′), 62.7 (C-5), 36.1 (C-1), 34.9 (C-4), 33.7 (C-2), 25.5 (C-3) ppm. MS (IS): *m/z* = 317 $[M - H]^-$. $C_{21}H_{22}N_2O$ (318.42). calcd. C 79.21, H 6.96, N 8.79; found C 79.10, H 6.95, N 8.76. M.p. 190 °C (dec.).

Compound 2b: Yield 45%, 143 mg. Starting materials: indole and 5-hydroxypentanal; Procedure B3. TLC (hexane/*i*PrOH, 97.5:2.5; R_f = 0.51); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 40:60; flow: 1 mL/min; room temp. 6.16 min). Racemic mixture. ^{1}H NMR (600 MHz, [D_3]CD_3CN): δ = 9.14 (br. s, 1 H, H-1′), 8.97 (br. s, 1 H, H-1′′), 7.48−7.44 (m, 2 H, H-4′,4′′), 7.39 (d, *J* = 8.2 Hz, 1 H, H-7′), 7.23−7.19 (m, 2 H, H-7′′,2′), 7.08 (t, *J* = 8.2 Hz, 1 H, H-6′), 7.02−6.95 (m, 2 H, H-5′′,6′′), 6.94 (t, *J* = 8.2 Hz, 1 H, H-5′), 6.36 (m, 1 H, H-3′′), 4.38 (t, *J* = 7.6 Hz, 1 H, H-1), 3.47 (t, *J* = 6.6 Hz, 2 H, H-5), 2.24−2.18 (m, 2 H, H-2), 1.59−1.52 (m, 2 H, H-4), 1.42−1.32 (m, 2 H, H-3) ppm. ^{13}C NMR (100 MHz, [D_3]CD_3CN): δ = 144.7 (C-2′′), 137.9 (C-7′a), 137.2 (C-7′′a), 129.7 (C-4′′a), 127.8 (C-4′a), 123.3 (C-2′), 122.6 (C-6′), 121.5 (C-6′′), 120.5 (C-4′′), 120.1 (C-4′), 120.0 (C-5′′), 119.8 (C-5′), 118.3 (C-3′), 112.4 (C-7′), 111.6 (C-7′′), 99.5 (C-3′′), 62.6 (C-5), 37.3 (C-1), 35.2 (C-4), 33.5 (C-2), 25.2 (C-3) ppm. . MS (IS): *m/z* = 317 $[M - H]^-$. $C_{21}H_{22}N_2O$ (318.20): calcd. C 79.21, H 6.96, N 8.79; found C 78.64, H 7.15, N 8.45. M.p. 200 °C (dec.).

Compound 3b: Yield 12%, 38 mg. Starting materials: indole and 5-hydroxypentanal; Procedure B1. TLC (hexane/*i*PrOH, 9:1; R_f = 0.64); HPLC RP-18 (Tracer, 250 × 4.6, 5 µm; H_2O/CH_3CN, 40:60; flow: 1 mL/min; room temp. 10.9 min). ^{1}H NMR (300 MHz, [D_6]DMSO): δ = 10.72 (br. s, 2 H, H-1′), 7.50 (d, *J* = 8.1 Hz, 2 H, H-4′), 7.29 (d, *J* = 8.1 Hz, 2 H, H-7′), 7.22 (d, *J* = 2.0 Hz, 2 H, H-2′), 6.99 (t, *J* = 8.1 Hz, 2 H, H-6′), 6.86 (t, *J* = 8.1 Hz, 2 H, H-5′), 4.39 (ddd, J_1 = 47.4, J_2 = J_3 = 5.9 Hz, 2 H, H-5), 4.38 (t, *J* = 7.5 Hz, 1 H, H-1), 2.27−2.16 (m, 2 H, H-2), 1.80−1.58 (m, 2 H, H-4), 1.47−1.30 (m, 2 H, H-3) ppm. MS (IS): *m/z* = 319 $[M - H]^-$. $C_{21}H_{21}FN_2$ (320.20): calcd. C 78.72, H 6.61, N 8.74; found C 78.64, H 6.55, N 8.65. Yellow oil (hygroscopic).

Compound 4b: Yield 11%, 35 mg. Starting materials: indole and 5-hydroxypentanal; Procedure B1. TLC (hexane/*i*PrOH, 85:15; R_f = 0.44); HPLC RP-18 (Tracer, 250 × 4.6, 5 µm; H_2O/CH_3CN, 40:60; flow: 1 mL/min; room temp. 14.2 min). Racemic mixture. ^{1}H NMR (600 MHz, [D_6]DMSO): δ = 10.87 (br. s, 1 H, H-1′), 10.72 (br. s, 1 H, H-1′′), 7.47 (d, *J* = 8.1 Hz, 1 H, H-4′), 7.38 (d, *J* = 8.1 Hz, 1 H, H-4′′), 7.32 (d, *J* = 8.1 Hz, 1 H, H-7′), 7.25−7.22 (m, 2 H, H-2′,7′′), 7.01 (t, *J* = 8.1 Hz, 1 H, H-6′), 6.94 (t, *J* = 8.1 Hz, 1 H, H-6′′), 6.88 (t, *J* = 8.1 Hz, 2 H, H-5′,5′′), 6.25 (d, *J* = 1.6 Hz, 1 H, H-3′′), 4.39 (ddd, J_1 = 47.4, J_2 = J_3 = 6.0 Hz, 2 H, H-5), 4.32 (t, *J* = 7.7 Hz, 1 H, H-1), 2.25−2.13 (m, 2 H, H-2), 1.77−1.60 (m, 2 H, H-4), 1.41−1.32 (m, 2 H, H-3) ppm. ^{13}C NMR (100 MHz, [D_6]DMSO): δ = 143.4 (C-2′′), 136.3 (C-7′a), 136.0 (C-7′′a), 128.0 (4′′a), 126.4 (C-4′a), 122.2 (C-2′), 120.8 (C-6′), 119.8 (C-6′′), 119.1 (C-4′′), 118.7 (C-4′), 118.4 (C-5′′), 118.1 (C-5′), 116.7 (C-3′), 111.3 (C-7′), 110.7 (C-7′′), 97.9 (C-3′′), 83.8 (d, *J* = 162 Hz, C-5), 35.8 (C-1), 34.0 (C-2), 29.7 (d, *J* = 19 Hz, C-4), 23.4 (d, *J* = 5 Hz, C-3) ppm. ^{19}F NMR (470 MHz, [D_6]DMSO): δ = −217.40 ppm. MS (IS): *m/z* = 319 $[M - H]^-$. $C_{21}H_{21}FN_2$ (320.20): calcd. C 78.72, H 6.61, N 8.74; found C 77.65, H 6.60, N 8.23. M.p. 77−81 °C (hygroscopic).

1,1-Bis(indol-3′-yl)-2,3;5,6-di-*O*-isopropylidene-1-deoxy-D-mannitol (7):[15] Yield 55%, 262 mg. ^{1}H NMR (500 MHz, [D_3]CD_3CN): δ = 9.18 (br. s, 1 H, H-1′), 8.99 (br. s, 1 H, H-1′′), 7.73 (d, *J* = 7.9 Hz, 1 H, H-4′), 7.51 (d, *J* = 7.9 Hz, 1 H, H-4′′), 7.41 (d, *J* = 2.4 Hz, 1 H, H-2′′), 7.34 (d, *J* = 7.9 Hz, 1 H, H-7′′), 7.31 (d, *J* = 7.9 Hz, 1 H, H-7′), 7.09−7.02 (m, 3 H, H-2′,6′,6′′), 6.99−6.92 (m, 2 H, H-5′,5′′), 5.32 (dd, J_1 = 11.0, J_2 = 6.7 Hz, 1 H, H-2), 5.06 (d, *J* = 11.0 Hz, 1 H, H-1), 4.40 (d, *J* = 6.7 Hz, 1 H, H-3), 3.90−3.80 (m, 2 H, H-5,6a), 3.71 (dd, J_1 = 8.2, J_2 = 4.3 Hz, 1 H, 1 H, H-6b), 3.33 (t, *J* = 8.2 Hz, 1 H, H-4), 2.69 (d, *J* = 8.2 Hz, 1 H, 4-OH), 1.44 (s, 3 H, H-4′′′a), 1.35 (s, 3 H, H-4′′′b), 1.15 (s, 3 H, H-4′′′′a), 0.80 (s, 3 H, H-4′′′′b) ppm. ^{13}C NMR (75 MHz, [D_3]CD_3CN): δ = 137.4 (C-7′a), 137.2 (C-7′′a), 128.1 (C-4′a), 127.7 (C-4′′a), 123.5 (C-2′), 122.6 (C-6′′), 122.5 (C-2′′), 122.1 (C-6′), 120.6 (C-4′), 119.8 (C-5′′), 119.7 (C-4′′), 119.5 (C-5′), 119.1 (C-3′), 116.7 (C-3′′), 112.2 (C-7′′), 112.1 (C-7′), 109.4 (C-2′′′′), 108.6 (C-2′′′), 80.5 (C-2), 77.1 (C-3), 77.0 (C-5), 70.5 (C-4), 67.2 (C-6), 34.7 (C-1), 26.8 (C-4′′′a), 26.6 (C-4′′′b), 25.6 (C-4′′′′a), 24.9 (C-4′′′′b) ppm.

1,1-Bis(7-azaindol-3-yl)-2,3;5,6-di-*O*-isopropylidene-1-deoxy-D-mannitol (8): Yield 22%, 105 mg. Starting materials: 7-azaindole and 2,3:5,6-di-*O*-isopropylidene-D-mannofuranose. Procedure A. TLC (CH_2Cl_2/CH_3COCH_3, 1:1; R_f = 0.17); HPLC RP-18 (Tracer, 250 × 4.6, 5 µm; H_2O/CH_3CN, 60:30; flow: 1 mL/min; room temp. 9.73 min). ^{1}H NMR (600 MHz, [D_3]CD_3CN): δ = 9.61 (br. s, 1 H, H-1′), 9.39 (br. s, 1 H, H-1′′), 8.19 (dd, J_1 = 4.7, J_2 = 1.3 Hz, 1 H, H-6′), 8.16 (dd, J_1 = 4.7, J_2 = 1.3 Hz, 1 H, H-6′′), 8.03 (dd, J_1 = 7.7, J_2 = 1.3 Hz, 1 H, H-4′′) 7.85 (dd, J_1 = 7.7, J_2 = 1.3 Hz, 1 H, H-4′), 7.53 (d, *J* = 2.3 Hz, 1 H, H-2′), 7.13 (d, *J* = 2.3 Hz, 1 H, H-2′′), 6.98 (dd, J_1 = 7.7, J_2 = 4.7 Hz, 2 H, H-5′,5′′), 5.24 (dd, J_1 = 10.9, J_2 = 6.8 Hz, 1 H, H-2), 5.04 (d, *J* = 10.9 Hz, 1 H, H-1), 4.40 (d, *J* = 6.8 Hz, 1 H, H-3), 3.88 (dd, J_1 = 8.3, J_2 = 6.2 Hz, 1 H, H-6a), 3.83 (m, 1 H, H-5), 3.72 (dd, J_1 = 8.3, J_2 = 4.3 Hz, 1 H, H-6b), 3.26 (t, J_1 = J_2 = 8.3 Hz, 1 H, H-4), 2.74 (d, *J* = 8.3 Hz, 1 H, 4-OH), 1.45 (s, 3 H, H-4a′′′), 1.34 (s, 3 H, H-4b′′′), 1.15 (s, 3 H, H-4a′′′′), 0.79 (s, 3 H, H-4b′′′′) ppm. ^{13}C NMR (100 MHz, [D_3]CD_3CN): δ = 149.8 (C-7′a), 149.7 (C-7′′a), 144.5 (C-6′), 143.9 (C-6′′), 129.0 (C-4′′), 128.0 (C-4′), 123.9 (C-2′′), 123.3 (C-2′), 120.4 (C-4a′′), 119.9 (C-4′a), 117.8 (C-3′′), 116.5 (C-5′), 116.2 (C-5′′), 115.2 (C-3′), 109.6 (C-2′′′′), 108.9 (C-2′′′), 80.3 (C-2), 77.1 (C-3), 77.0 (C-5), 70.8 (C-4), 67.4 (C-6), 35.2 (C-1), 26.9 (C-4a′′′), 26.8 (C-4b′′′′), 25.7 (C-4a′′′′), 25.0 (C-4b′′′) ppm. MS (IS): *m/z* =

477 $[M - H]^-$. $C_{26}H_{30}N_4O_5$ (478.21): calcd. C 65.26, H 6.32, N 11.70; found C 65.47, H 6.35, N 12.01. M.p. 210 °C (dec.).

Compound 9: Yield 40%, 212 mg. Starting materials: 5-benzyloxyindole and 5-hydroxypentanal; Procedure B1. TLC (hexane/*i*PrOH, 75:25; R_f = 0.24); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 30:70; flow: 1 mL/min; room temp. 6.0 min). ^1H NMR (300 MHz, $CDCl_3$): δ = 7.90 (br. s, 2 H, H-1′), 7.40−6.90 (m, 18 H, H-10′, 11′, 12′, 4′, 6′, 7′, 2′), 5.05 (s, 4 H, H-8′), 4.35 (t, *J* = 7.5 Hz, 1 H, H-1), 3.60 (br. t, *J* = 6.5 Hz, 2 H, H-5), 2.25−2.15 (m, 2 H, H-2), 1.70−1.40 (m, 4 H, H-3,4) ppm. MS (IS): *m*/*z* = 529 $[M - H]^-$. $C_{35}H_{34}N_2O_3$ (530.67): calcd. C 79.22, H 6.46, N 5.28; found C 79.00, H 6.47, N 5.22. Yellow oil.

Compound 10: Yield 13%, 40 mg. Starting materials: 7-azaindole and 2-methoxytetrahydrofuran; Procedure A. TLC (hexane/*i*PrOH, 75:25; R_f = 0.18); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 60:40; flow: 1 mL/min; room temp. 4.4 min). ^1H NMR (600 MHz, $[D_6]DMSO$): δ = 11.30 (br. s, 2 H, H-1′), 8.10 (dd, J_1 = 4.5, J_2 = 1.3 Hz, 2 H, H-6′), 7.83 (dd, J_1 = 7.7, J_2 = 1.3 Hz, 2 H, H-4′), 7.38 (d, *J* = 2.3 Hz, 2 H, H-2′), 6.90 (dd, J_1 = 7.7, J_2 = 4.5 Hz, 2 H, H-5′), 4.37−4.31 (m, 2 H, H-1, H-4-OH), 3.45−3.40 (m, 2 H, H-4), 2.22−2.16 (m, 2 H, H-2), 1.47−1.41 (m, 2 H, H-3) ppm. ^{13}C NMR (75 MHz, $[D_6]DMSO$): δ = 148.7 (C-7′a), 142.1 (C-6′), 126.9 (C-4′), 122.3 (C-2′), 118.7 (C-4′a), 117.2 (C-3′), 114.5 (C-5′), 60.6 (C-4), 33.5 (C-1), 31.2 (C-3), 30.7 (C-2) ppm. MS (IS): *m*/*z* = 305 $[M - H]^-$. $C_{18}H_{18}N_4O$ (306.37): calcd. C 70.57, H 5.92 N 18.29; found C 70.67, H 5.60 N 18.10. M.p. 221 °C (dec.).

Compound 11a: Yield 23%, 93 mg. Starting materials: 5,6-(methylenedioxy)indole and 5-hydroxypentanal. Procedure B1. TLC (hexane/*i*PrOH, 97.5:2.5; R_f = 0.55); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 50:50; flow: 1 mL/min; room temp. 6.7 min). ^1H NMR (600 MHz, $[D_3]CD_3CN$): δ = 8.86 (br. s, 2 H, H-1′), 7.03 (d, *J* = 2.3 Hz, 2 H, H-2′), 6.82 (s, 4 H, H-4′,7′), 5.82−5.80 (m, 4 H, H-8′), 4.19 (t, *J* = 7.5 Hz, 1 H, H-1), 3.46−3.42 (m, 2 H, H-5), 2.39 (br. t, 1 H, 5-OH), 2.17−2.10 (m, 2 H, H-2), 1.55−1.48 (m, 2 H, H-4), 1.38−1.30 (m, 2 H, H-3) ppm. ^{13}C NMR (75 MHz, $[D_3]CD_3CN$): δ = 145.7, 143.3 (C-5′, C-6′), 133.0 (C-7′a), 122.2 (C-4′a), 121.8 (C-2′), 121.0 (C-3′), 101.9 (C-8′), 99.1 (C-4′), 93.4 (C-7′), 63.1 (C-5), 35.9 (C-1), 35.4 (C-4), 34.0 (C-2), 25.8 (C-3) ppm. MS (IS): *m*/*z* = 407 $[M + H]^+$. $C_{23}H_{22}N_2O_5$ (406.44): calcd. C 67.97, H 5.46, N 6.89; found C 67.95, H 5.51, N 6.82. M.p. 200 °C (dec.).

Compound 11b: Yield 24%, 97 mg. Starting materials: 5,6-(methylenedioxy)indole and 5-hydroxypentanal; Procedure B3. TLC (hexane/*i*PrOH, 97.5:2.5; R_f = 0.63); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 50:50; flow 1 mL/min; room temp. 8.2 min). Racemic mixture. ^1H NMR (600 MHz, $[D_3]CD_3CN$): δ = 8.97 (br. s, 1 H, H-1′), 8.78 (br. s, 1 H, H-1″), 7.03 (d, *J* = 2.4 Hz, 1 H, H-2′), 6.87 (s, 1 H, H-4″), 6.86 (s, 1 H, H-7′), 6.80 (s, 1 H, H-4′), 6.72 (s, 1 H, H-7″), 6.21 (d, *J* = 2.1 Hz, 1 H, H-3″), 5.85−5.80 (m, 4 H, H-8′, 8″), 4.18 (t, *J* = 7.6 Hz, 1 H, H-1), 3.45 (br. t, *J* = 6.4 Hz, 2 H, H-5), 2.42 (br. s, 1 H, 5-OH), 2.13−2.08 (m, 2 H, H-2), 1.55−1.49 (m, 2 H, H-4), 1.38−1.31 (m, 2 H, H-3) ppm. ^{13}C NMR (75 MHz, $[D_3]CD_3CN$): δ = 145.6 (C-5′/6′), 144.7 (C-5″/6″), 143.4 (C-6′/5′), 143.3 (C-6″/5″), 143.1 (C-2″), 132.6 (C-7′a), 131.8 (C-7″a), 123.3 (C-4″a), 121.8 (C-2′), 121.7 (C-4′a), 118.7 (C-3′), 101.6, 101.3 (C-8′, 8″), 99.8 (C-3″), 99.3 (C-4″), 98.5 (C-4′), 93.1 (C-7′), 92.7 (C-7″), 62.6 (C-5), 37.3 (C-1), 35.0 (C-4), 33.5 (C-2), 25.2 (C-3) ppm. . MS (IS): *m*/*z* = 407 $[M + H]^+$. $C_{23}H_{22}N_2O_5$ (406.18): calcd. C 67.98, H 5.42, N 6.89; found C 67.75; H 5.38, N 6.75. M.p. 220 °C (dec.).

Compound 12a: Yield 35%, 137 mg. Starting materials: 5,6-(methylenedioxy)indole and 2-methoxytetrahydrofuran; Procedure B1. TLC (hexane/*i*PrOH, 75:25; R_f = 0.44); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 60:40; flow: 1 mL/min; room temp. 17.5 min). ^1H NMR (600 MHz, $[D_3]CD_3CN$): δ = 8.88 (br. s, 2 H, H-1′), 7.04 (d, *J* = 2.2 Hz, 2 H, H-2′), 6.83 (s, 4 H, H-4′,7′), 5.83−5.81 (m, 4 H, H-8′), 4.21 (t, *J* = 7.5 Hz, 1 H, H-1), 3.54−3.50 (m, 2 H, H-4), 2.47 (br. t, *J* = 5.0 Hz, 1 H, 4-OH), 2.20−2.13 (m, 2 H, H-2), 1.55−1.48 (m, 2 H, H-3) ppm. ^{13}C NMR (75 MHz, $[D_3]CD_3CN$): δ = 145.3, 142.9 (C-5′, C-6′), 132.6 (C-7′a), 121.8 (C-4′a), 121.5 (C-2′), 120.6 (C-3′), 101.5 (C-8′), 98.7 (C-4′), 93.0 (C-7′), 62.6 (C-4), 34.8 (C-1), 35.3 (C-4), 31.9(C-2) ppm. MS (IS): *m*/*z* = 391 $[M - H]^-$. $C_{22}H_{20}N_2O_5$ (392.41): calcd. C 67.34, H 5.14, N 7.14; found C 67.30, H 5.20, N 7.10. M.p. 240 °C (dec.)

Compound 12b: Yield 26%, 102 mg. Starting materials: 5,6-(methylenedioxy)indole and 2-methoxytetrahydrofuran; Procedure B3. TLC (hexane/*i*PrOH, 75:25; R_f = 0.41); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 60:40; flow: 1 mL/min; room temp. 23.4 min). Racemic mixture. ^1H NMR (600 MHz, $[D_3]CD_3CN$): δ = 8.98 (br. s, 1 H, H-1′), 8.79 (br. s, 1 H, H-1″), 7.03 (d, *J* = 2.4 Hz, 1 H, H-2′), 6.88 (s, 1 H, H-4″), 6.86 (s, 1 H, H-7′), 6.80 (s, 1 H, H-4′), 6.72 (s, 1 H, H-7″), 6.22 (d, *J* = 2.1 Hz, 1 H, H-3″), 5.84−5.81 (m, 4 H, H-8′,8″), 4.19 (t, *J* = 7.7 Hz, 1 H, H-1), 3.54−3.49 (m, 2 H, H-4), 2.50 (br. t, *J* = 4.9 Hz, 1 H, 4-OH), 2.14−2.10 (m, 2 H, H-2), 1.53−1.46 (m, 2 H, H-3) ppm. ^{13}C NMR (75 MHz, $[D_3]CD_3CN$): δ = 145.6 (C-5′,6′), 144.7 (C-5″,6″), 143.4 (C-6′,5′), 143.3 (C-6″,5″), 143.0 (C-2″), 132.7 (C-7′a), 131.8 (C-7″a), 123.3 (C-4″a), 121.8 (C-2′), 121.7 (C-4′a), 118.7 (C-3′), 101.6, 101.4 (C-8′,8″), 99.9 (C-3″), 99.3 (C-4″), 98.5 (C-4′), 93.1 (C-7′), 92.7 (C-7″), 62.5 (C-4), 37.2 (C-1), 32.1 (C-3), 31.6 (C-2) ppm. MS (IS): *m*/*z* = 391 $[M - H]^-$. $C_{22}H_{20}N_2O_5$ (392.41): calcd. C 67.34, H 5.14, N 7.14; found C 67.14, H 5.36, N 7.10. M.p. 205 °C (dec.).

Compound 13: Yield 15%, 59 mg. Starting materials: 5,6-(methylenedioxy)indole and 2-methoxytetrahydrofuran; Procedure B2. TLC (hexane/*i*PrOH, 75:25; R_f = 0.60); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 60:40; flow: 1 mL/min; room temp. 19.9 min). ^1H NMR (300 MHz, $[D_3]CD_3CN$): δ = 9.10 (br. s, 2 H, H-1′), 7.05 (s, 2 H, H-4′,7′), 6.90 (s, 2 H, H-7′,4′), 6.40 (s, 2 H, H-3′), 6.00 (s, 4 H, H-8′), 4.25 (t, *J* = 7.5 Hz, 1 H, H-1), 3.62 (t, *J* = 6.7 Hz, 2 H, H-4), 2.30−2.20 (m, 2 H, H-2), 1.70−1.60 (m, 2 H, H-3) ppm. ^{13}C NMR (75 MHz, $[D_3]CD_3CN$): δ = 145.1, 143.6 (C-5′, C-6′), 140.9 (C-2′), 132.1 (C-7′a), 123.0 (C-4′a), 101.5 (C-8′), 100.5 (C-3′), 99.5 (C-4′), 92.9 (C-7′), 62.5 (C-4), 39.6 (C-1), 31.9 (C-3), 31.4 (C-2) ppm. MS (IS): *m*/*z* = 391 $[M - H]^-$. $C_{22}H_{20}N_2O_5$ (392.41): calcd. C 67.34, H 5.14, N 7.14; found C 67.26, H 5.35, N 7.10. M.p. 250 °C (dec.).

1-(1*H*-Indol-3-yl)-2,3,4,9-tetrahydro-1*H*-carbazole (5a): Yield 64%, 183 mg. Starting material: **1a**; Procedure C. TLC (hexane/*i*PrOH, 9:1; R_f = 0.66); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 40:60; flow: 1 mL/min; room temp. 8.4 min). Racemic mixture. ^1H NMR (600 MHz, $[D_3]CD_3CN$): δ = 9.10 (br. s, 1 H, H-1′), 8.60 (s, 1 H, H-9), 7.46 (m, 1 H, H-5), 7.40 (ddd, J_1 = 8.2, J_2 = J_3 = 0.9 Hz, 1 H, H-7′), 7.29 (ddd, J_1 = 8.1, J_2 = 1.8, J_3 = 0.8 Hz, 1 H, H-4′), 7.15 (m, 1 H, H-8), 7.09 (m, 1 H, H-6′), 7.03−6.97 (m, 2 H, H-6,7), 6.98 (d, *J* = 2.4 Hz, 1 H, H-2′), 6.92 (m, 1 H, H-5′), 4.46 (m, 1 H, H-1), 2.83−2.79 (m, 2 H, H-4), 2.23 (m, 1 H, H-2a), 2.12−1.99 (m, 2 H, H-2b,3a), 1.86 (m, 1 H, H-3b) ppm. ^{13}C NMR (100 MHz, $[D_3]CD_3CN$): δ = 137.9 (C-1a), 137.8 (C-7′a), 137.0 (C-8a), 128.6 (C-5a), 127.5 (C-4′a), 123.9 (C-2′), 122.4 (C-6′), 121.5 (C-7), 119.8 (C-4′), 119.7 (C-5′), 119.4 (C-6), 118.7 (C-3′), 118.6 (C-5), 112.4 (C-7′), 111.5 (C-8), 110.6 (C-4a), 33.2 (C-1), 33.1 (C-2), 23.1 (C-3), 21.8 (C-4) ppm. MS (IS): *m*/*z* =

287 [M + H]$^+$. $C_{20}H_{18}N_2$ (286.20): calcd. C 83.30, H 6.99, N 9.71; found C 83.21, H 6.91, N 9.53. M.p. 207 °C.

4-(1*H*-Indol-3-yl)-2,3,4,9-tetrahydro-1*H*-carbazole (6a): Yield 7%, 20 mg. Starting material: **1a**; Procedure C. TLC (hexane/*i*PrOH, 9:1; R_f = 0.55); HPLC RP-18 (Waters 250 × 4.6, 5 µm; H_2O/CH_3CN, 40:60; flow: 1 mL/min; room temp. 12.4 min). Racemic mixture. ^{1}H NMR (600 MHz, $[D_3]CD_3CN$): δ = 8.96 (br. s, 1 H, H-1′), 8.94 (s, 1 H, H-9), 7.44 (d, *J* = 7.8 Hz, 1 H, H-4′), 7.36 (ddd, J_1 = 8.2, J_2 = J_3 = 0.9 Hz, 1 H, H-7′), 7.27 (ddd, J_1 = 8.1, J_2 = J_3 = 0.9 Hz, 1 H, H-8), 7.07 (m, 1 H, H-6′), 6.96−6.90 (m, 2 H, H-7,5′), 6.84 (d, *J* = 8.1 Hz, 1 H, H-5), 6.77 (d, *J* = 2.4 Hz, 1 H, H-2′), 6.71 (m, 1 H, H-6), 4.50 (t, *J* = 5.9 Hz, 1 H, H-4), 2.90−2.76 (m, 2 H, H-1), 2.17 (m, 1 H, H-3a), 2.05 (m, 1 H, H-3b), 1.95 (m, 1 H, H-2a), 1.84 (m, 1 H, H-2b) ppm. ^{13}C NMR (100 MHz, $[D_3]CD_3CN$): δ = 137.9 (C-7′a), 137.1 (C-8a), 136.2 (C-1a), 128.5 (C-5a), 127.7 (C-4′a), 123.7 (C-2′), 122.1 (C-6′), 121.2 (C-7), 120.9 (C-3′), 119.9 (C-4′), 119.3 (C-5′), 119.2 (C-5), 119.1 (C-6), 112.5 (C-4a), 112.3 (C-7′), 111.3 (C-8), 32.9 (C-3), 31.2 (C-4), 23.9 (C-1), 21.8 (C-2) ppm. . MS (IS): *m*/*z* = 287 [M + H]$^+$. $C_{20}H_{18}N_2$ (286.20): calcd. C 83.30, H 6.99, N 9.71; found C 82.95, H 6.95, N 9.51. M.p. 182 °C.

6-(1*H*-Indol-3-yl)-5,6,7,8,9,10-hexahydrocyclohepta[*b*]indole (5b): Yield 65%, 195 mg. Starting materials: **2b**−**1b**; Procedure C. TLC (hexane/*i*PrOH, 95:5; R_f = 0.22); HPLC RP-18 (Waters 300 × 3.3, 5 µm; H_2O/CH_3CN, 40:60; flow: 1 mL/min; room temp. 22.1 min). M.p. 206−208 °C. Racemic mixture. ^{1}H NMR (500 MHz, $[D_6]$DMSO): δ = 10.80 (br. s, 1 H, H-1′), 10.41 (s, 1 H, H-5), 7.49 (d, *J* = 7.9 Hz, 1 H, H-4′), 7.44 (m, 1 H, H-1), 7.36 (d, *J* = 8.0 Hz, 1 H, H-7′), 7.18 (m, 1 H, H-4), 7.07 (t, *J* = 8.0 Hz, 1 H, H-6′), 6.99−6.91 (m, 3 H, H-5′,2,3), 6.68 (d, *J* = 2.2 Hz, 1 H, H-2′), 4.64 (dd, J_1 = 5.9, J_2 = 3.1 Hz, 1 H, H-6), 2.97 (m, 1 H, H-10a), 2.75 (m, 1 H, H-10b), 2.36 (m, 1 H, H-7a), 1.98 (m, 1 H, H-7b), 1.88 (m, 1 H, H-9a), 1.76 (m, 1 H, H-8a), 1.71−1.53 (m, 2 H, H-8b,9b) ppm. ^{13}C NMR (75 MHz, $[D_6]$DMSO): δ = 139.7 (C-5a), 136.6 (C-7′a), 134.2 (C-4a), 128.6 (C-1a), 126.0 (C-4′a), 123.5 (C-2′), 120.7 (C-6′), 119.6 (C-3), 118.5 (C-4′), 118.2 (C-5′), 117.7 (C-2), 117.2 (C-1), 115.6 (C-3′), 111.4 (C-7′,10a), 110.5 (C-4), 36.3 (C-6), 33.2 (C-7), 28.6 (C-9), 26.5 (C-8), 24.0 (C-10) ppm. MS (IS): *m*/*z* = 299 [M − H]$^-$. $C_{21}H_{20}N_2$ (300.20): calcd. C 83.96, H 6.71, N 9.33; found C 81.19, H 6.50, N 9.03.

10-(1*H*-Indol-3-yl)-5,6,7,8,9,10-hexahydrocyclohepta[*b*]indole (6b): Yield 6%, 18 mg. Starting materials: **2b**−**1b**; Procedure C. TLC (hexane/*i*PrOH, 95:5; R_f = 0.15); HPLC RP-18 (Waters 300 × 3.3, 5 µm; H_2O/CH_3CN, 40:60, flow: 1 mL/min, room temp. 16.6 min). Racemic mixture. ^{1}H NMR (300 MHz, $[D_6]$DMSO): δ = 10.68 (br. s, 1 H, H-5), 10.61 (s, 1 H, H-1′), 7.62 (d, *J* = 7.7 Hz, 1 H, H-4′), 7.31 (d, *J* = 7.9 Hz, 1 H, H-7′), 7.24 (d, *J* = 7.9 Hz, 1 H, H-4), 7.14 (d, *J* = 7.9 Hz, 1 H, H-1), 7.05 (t, *J* = 7.9 Hz, 1 H, H-6′), 6.97 (t, *J* = 7.7 Hz, 1 H, H-5′), 6.93 (t, *J* = 7.9 Hz, 1 H, H-3), 6.79 (t, *J* = 7.9 Hz, 1 H, H-2), 6.48 (br. s, 1 H, H-2′), 4.79 (t, *J* = 3.9 Hz, 1 H, H-10), 2.98−2.87 (m, 2 H, H-6), 2.45 (m, 1 H, H-9a), 2.01−1.81 (m, 2 H, H-9b,7a), 1.72 (m, 1 H, H-8a), 1.63−1.43 (m, 2 H, H-7b,8b) ppm. ^{13}C NMR (75 MHz, $[D_6]$DMSO): δ = 137.4 (C-5a), 136.7 (C-7′a), 134.3 (C-4a), 128.5 (C-1a), 126.2 (C-4′a), 123.5 (C-2′), 120.5 (C-6′), 119.6 (C-3), 118.6 (C-4′), 118.0 (C-5′), 117.7 (C-2), 117.4 (C-3′), 117.1 (C-1), 114.5 (C-10a), 111.3 (C-7′), 110.2 (C-4), 33.7 (C-9), 31.8 (C-10), 28.3 (C-6), 27.3 (C-7), 25.2 (C-8) ppm. MS (IS): *m*/*z* = 299 [M − H]$^-$. $C_{21}H_{20}N_2$ (300.20): calcd. C 83.96, H 6.71, N 9.33; found C 82.29, H 6.53, N 9.11. M.p. 170 °C.

Compound 14: Yield 70%, 321 mg. Starting material: **7** − Procedure C. TLC (hexane/acetone, 8:2, R_f = 0.75); HPLC RP-18 (Waters 300 × 3.3, 5 µm; H_2O/CH_3CN, 40:60, flow: 1 mL/min; room temp. 12.8 min). Only one diastereoisomer was isolated (configuration at C1/C4: undetermined). ^{1}H NMR (300 MHz, $[D_3]CD_3CN$): δ = 9.23 (br. s, 1 H, H-1′), 8.91 (s, 1 H, H-9), 7.69 (m, 1 H, H-5), 7.51 (d, *J* = 7.8 Hz, 1 H, H-4′), 7.48 (d, *J* = 8.0 Hz, 1 H, H-7′), 7.30−7.15 (m, 2 H, H-8,6′), 7.13−7.02 (m, 3 H, H-7,6,5′), 6.94 (d, *J* = 2.4 Hz, 1 H, H-2′), 4.72−4.61 (m, 2 H, H-4′′,2), 4.53 (d, *J* = 5.6 Hz, 1 H, H-3), 4.52 (d, *J* = 5.5 Hz, 1 H, H-1), 3.97 (dd, J_1 = 8.4, J_2 = 6.4 Hz, 1 H, H-5′′a), 3.73−3.65 (m, 2 H, H-5′′b,4), 1.46 (s, 3 H, H-4′′′a), 1.43 (s, 3 H, H-6′′a), 1.40 (s, 3 H, H-4′′′b), 1.34 (s, 3 H, H-6′′b) ppm. ^{13}C NMR (75 MHz, $[D_3]CD_3CN$): δ = 137.9 (C-7′a), 137.7 (C-8a), 135.7 (C-1a), 128.2 (C-5a), 127.5 (C-4′a), 124.5 (C-2′), 122.7 (C-6′), 121.9 (C-7), 120.1 (C-5,5′), 119.9 (C-4′), 119.8 (C-6), 115.9 (C-3′), 112.5 (C-7′), 111.9 (C-8), 109.7 (C-2′′), 108.4 (C-2′′′), 107.6 (C-4a), 80.8 (C-2), 78.0 (C-4′′), 75.9 (C-3), 68.3 (C-5′′), 40.8 (C-4), 38.1 (C-1), 28.3 (C-4′′′a), 26.8 (C-6′′a), 25.9 (C-4′′b), 25.5 (C-6′′b) ppm. MS (IS): *m*/*z* = 459 [M + H]$^+$. $C_{28}H_{30}N_2O_4$ (458.24): calcd. C 73.34, H 6.59, N 6.11; found C 73.11, H 6.63, N 5.55. M.p. 204−206 °C (dec.)

Compound 15: Yield 55%, 214 mg. Starting materials: **11a**−**11b**; Procedure C. TLC (hexane/EtOAc, 8:2, R_f = 0.23); HPLC RP-18 (Waters 300 × 3.3, 5 µm; H_2O/CH_3CN, 40:60, flow 1 mL/min, room temp. 15.4 min). M.p. 184 °C (dec.).Racemic mixture. ^{1}H NMR (500 MHz, $[D_3]CD_3CN$): δ = 9.01 (br. s, 1 H, H-1′), 8.37 (s, 1 H, H-5), 6.94 (s, 1 H, H-7′), 6.91 (s, 1 H, H-4′), 6.83 (s, 1 H, H-1), 6.80 (d, *J* = 2.3 Hz, 1 H, H-2′), 6.67 (s, 1 H, H-4), 5.90 (s, 2 H, H-8′), 5.85−5.83 (m, 2 H, H-11), 4.44 (dd, J_1 = 8.5, J_2 = 3.2 Hz, 1 H, H-6), 2.92−2.72 (m, 2 H, H-10), 2.27 (m, 1 H, H-7a), 2.05 (m, 1 H, H-7b), 1.89−1.73 (m, 4 H, H-8,9) ppm. ^{13}C NMR (100 MHz, $[D_3]CD_3CN$): δ = 145.5 (C-5′), 144.4 (C-2), 143.3 (C-6′), 142.9 (C-3), 139.3 (C-6a), 132.7 (C-7′a), 129.8 (C-4a), 124.0 (C-1a), 122.7 (C-2′), 121.3 (C-4′a), 118.2 (C-3′), 113.4 (C-10a), 101.5 (C-8′), 101.1 (C-11), 98.4 (C-1), 97.3 (C-4′), 93.0 (C-7′), 92.4 (C-4), 38.1 (C-6), 35.3 (C-7), 29.5 (C-8), 29.5 (C-9), 25.4 (C-10) ppm. MS (IS): *m*/*z* = 389 [M + H]$^+$. $C_{23}H_{20}N_2O_4$ (388.19): calcd. C 71.12, H 5.19, N 7.21; found C 70.95, H 5.00, N 7.12.

Compound 16: Yield 58%, 217 mg. Starting materials: **12a**−**12b**; Procedure C. TLC (hexane/*i*PrOH, 9:1, R_f = 0.31); HPLC RP-18 (Waters 300 × 3.3, 5 µm; H_2O/CH_3CN, 40:60, flow: 1 mL/min, room temp. 11.5 min). Racemic mixture. ^{1}H NMR (500 MHz, $[D_3]CD_3CN$): δ = 8.94 (br. s, 1 H, H-1′), 8.42 (s, 1 H, H-9), 6.88 (s, 2 H, H-7′,5), 6.85 (d, *J* = 2.4 Hz, 1 H, H-2′), 6.69 (s, 1 H, H-8), 6.61 (s, 1 H, H-4′), 5.87−5.81 (m, 4 H, H-10,8′), 4.30 (dd, J_1 = 7.8, J_2 = 6.6 Hz, 1 H, H-1), 2.77−2.66 (m, 2 H, H-4), 2.20 (m, 1 H, H-2a), 2.05−1.91 (m, 2 H, H-2b,3a), 1.81 (m, 1 H, H-3b) ppm. ^{13}C NMR (100 MHz, $[D_3]CD_3CN$): δ = 145.4 (C-5′), 144.6 (C-6), 143.2 (C-6′), 142.9 (C-7), 136.6 (C-1a), 132.6 (C-7′a), 131.6 (C-8a), 122.4 (C-2′,5a), 121.4 (C-4′a), 119.1 (C-3′), 110.8 (C-4a), 101.5 (C-10), 101.2 (C-8′), 98.2 (C-4′), 97.6 (C-5), 93.1 (C-7′), 92.8 (C-8), 33.3 (C-1), 33.0 (C-2), 23.2 (C-3), 21.8 (C-4) ppm. MS (IS): *m*/*z* = 375 [M + H]$^+$. $C_{22}H_{18}N_2O_4$ (374.19): calcd. C 70.58, H 4.85, N 7.48; found C 70.15, H 4.75, N 7.25. M.p. 200 °C (dec.)

2-Benzyloxy-6-[5-benzyloxy-1*H*-indol-3-yl]-5,6,7,8,9,10-hexahydrocyclohepta[*b*]indole (17): Yield 62%, 318 mg. Starting material: **9**; Procedure C. TLC (hexane/*i*PrOH, 9:1, R_f = 0.62); HPLC RP-18 (Waters 300 × 3.3, 5 µm; H_2O/CH_3CN, 40:60, flow: 1 mL/min, room temp. 27.1 min). M.p. 286 °C (dec.). Racemic mixture. ^{1}H NMR (500 MHz, $[D_3]CD_3CN$): δ = 9.04 (br. s, 1 H, H-1′), 8.43 (s, 1 H, H-5), 7.47 (d, *J* = 7.6 Hz, 2 H, H-13), 7.39 (d, *J* = 7.6 Hz, 2 H, H-10′), 7.38 (t, *J* = 7.6 Hz, 2 H, H-14), 7.35−7.25 (m, 5 H, H-11′,7′,15,12′), 7.05 (d, *J* = 2.4 Hz, 1 H, H-1), 7.04 (d, *J* = 8.7 Hz, 1 H, H-4), 6.93 (d, *J* = 2.5 Hz, 1 H, H-4′), 6.90 (d, *J* = 2.3 Hz, 1

H, H-2′), 6.84 (dd, J_1 = 8.8, J_2 = 2.5 Hz, 1 H, H-6′), 6.71 (dd, J_1 = 8.7, J_2 = 2.4 Hz, 1 H, H-3), 5.10 (s, 2 H, H-11), 4.96 (s, 2 H, H-8′), 4.52 (dd, J_1 = 8.4, J_2 = 2.6 Hz, 1 H, H-6), 2.89−2.81 (m, 2 H, H-10), 2.29 (m, 1 H, H-7a), 2.05 (m, 1 H, H-7b), 1.88 (m, 1 H, H-8a), 1.85−1.74 (m, 3 H, H-8b,9) ppm. ^{13}C NMR (100 MHz, $[D_3]CD_3CN$): δ = 153.6 (C-5′,2), 141.7 (C-5a), 139.3 (C-12), 139.0 (C-9′), 133.2 (C-7′a), 130.7 (C-4a), 130.5 (C-1a), 129.3 (C-14), 129.3 (C-11′), 128.6 (C-10′), 128.6 (C-13), 128.5 (C-15,12′), 127.9 (C-4′a), 125.0 (C-2′), 117.4 (C-3′), 113.2 (C-6′), 113.2 (C-10a), 113.1 (C-7′), 112.1 (C-4), 111.7 (C-3), 103.7 (C-4′), 102.5 (C-1), 71.4 (C-11), 71.3 (C-8′), 38.1 (C-6), 35.1 (C-7), 29.5 (C-8), 29.4 (C-9), 25.3 (C-10) ppm. MS (IS): *m/z* = 513 $[M + H]^+$. $C_{35}H_{32}N_2O_2$ (512.33): calcd. C 82.00, H 6.29, N 5.46; found C 81.08, H 6.17, N 5.25.

6,7-Methylenedioxy-4-[(5,6-methylenedioxy)-1*H*-indol-3-yl)-2,3,4,9-tetrahydro-1*H*-carbazole (18): Yield 5%, 19 mg. Starting materials: **12a−12b**; Procedure C. TLC (hexane/*i*PrOH, 9:1, R_f = 0.20); HPLC RP-18 (Waters 300 × 3.3, 5μm; H_2O/CH_3CN, 40:60, flow: 1 mL/min, room temp. 7.9 min). M.p. 228 °C (dec.). Racemic mixture. ^{1}H NMR (500 MHz, $[D_3]CD_3CN$): δ = 8.85 (br. s, 1 H, H-1′), 8.78 (s, 1 H, H-9), 6.88 (s, 1 H, H-7′), 6.81 (s, 1 H, H-8), 6.75 (d, *J* = 2.3 Hz, 1 H, H-2′), 6.73 (s, 1 H, H-4′), 6.21 (s, 1 H, H-5), 5.87−5.83 (m, 2 H, H-8′), 5.78−5.74 (m, 2 H, H-10), 4.31 (dd, J_1 = 6.9, J_2 = 5.8 Hz, 1 H, H-4), 2.88−2.70 (m, 2 H, H-1), 2.13 (m, 1 H, H-3a), 1.99 (m, 1 H, H-3b), 1.96 (m, 1 H, H-2a), 1.84 (m, 1 H, H-2b) ppm. ^{13}C NMR (100 MHz, $[D_3]CD_3CN$): δ = 145.2 (C-5′), 144.2 (C-6), 142.9 (C-6′), 142.4 (C-7), 134.7 (C-1a), 132.6 (C-7′a), 131.6 (C-8a), 122.3 (C-2′,5a), 121.5 (C-4′a), 120.9 (C-3′), 112.8 (C-4a), 101.4 (C-8′), 101.1 (C-10), 98.5 (C-4′), 98.3 (C-5), 93.0 (C-7′), 92.7 (C-8), 33.1 (C-3), 31.7 (C-4), 23.9 (C-1), 22.3 (C-2) ppm. MS (IS): *m/z* = 373 $[M - H]^-$. $C_{22}H_{18}N_2O_4$ (374.19): calcd. C 70.20, H 5.36, N 7.44; found C 70.28, H 5.37, N 7.40.

2-(Benzyloxy)-10-[5-benzyloxy-1*H*-indol-3-yl]-5,6,7,8,9,10-hexahydrocyclohepta[*b*]indole (19): Yield 5%, 26 mg. Starting material: **9**; Procedure C. TLC (hexane/*i*PrOH, 9:1, R_f = 0.4); HPLC RP-18 (Waters 300 × 3.3, 5 μm; H_2O/CH_3CN, 40:60, flow: 1 mL/min, room temp. 18.1 min). M.p. 237 °C (dec.). Racemic mixture. ^{1}H NMR (500 MHz, $[D_3]CD_3CN$): δ = 8.82−8.77 (br. s, 2 H, H-5,1′), 7.47 (d, *J* = 7.6 Hz, 2 H, H-10′), 7.43−7.20 (m, 9 H, H-11′,13,14,7′,15,12′), 7.17 (d, *J* = 8.7 Hz, 1 H, H-4), 7.16 (d, *J* = 2.5 Hz, 1 H, H-4′), 6.83 (dd, J_1 = 8.8, J_2 = 2.5 Hz, 1 H, H-6′), 6.75 (d, *J* = 2.5 Hz, 1 H, H-1), 6.69 (dd, J_1 = 8.7, J_2 = 2.5 Hz, 1 H, H-3), 6.55 (d, *J* = 2.2 Hz, 1 H, H-2′), 5.08 (s, 2 H, H-8′), 4.90 (m, 2 H, H-11), 4.71 (t, *J* = 4.3 Hz, 1 H, H-10), 2.97−2.82 (m, 2 H, H-6), 2.48 (m, 1 H, H-9a), 1.96 (m, 1 H, H-9b), 1.76 (m, 1 H, H-8a), 1.66−1.54 (m, 3 H, H-8b,7) ppm. ^{13}C NMR (100 MHz, $[D_3]CD_3CN$): δ = 153.5 (C-2), 153.4 (C-5′), 139.7 (C-5a), 139.2 (C-9′), 139.1 (C-12), 133.3 (C-7′a), 131.0 (C-4a), 130.5 (C-1a), 129.3 (C-14), 129.2 (C-11′), 128.7 (C-10′), 128.6 (C-13), 128.6 (C-12′), 128.5 (C-15), 128.1 (C-4′a), 125.3 (C-2′), 119.2 (C-3′), 116.1 (C-10a), 112.9 (C-7′), 112.9 (C-4), 111.8 (C-6′), 111.6 (C-3), 104.0 (C-4′), 102.5 (C-1), 71.4 (C-8′), 71.2 (C-11), 34.7 (C-9), 33.4 (C-10), 29.7 (C-6), 28.5 (C-7), 26.6 (C-8) ppm. MS (IS): *m/z* = 511 $[M - H]^-$. $C_{35}H_{32}N_2O_4$ (512.33): calcd. C 82.00, H 6.29, N 5.46; found C 81.20, H 6.08, N 5.25.

2-Hydroxy-6-(5-hydroxy-1*H*-indol-3-yl)-5,6,7,8,9,10-hexahydrocyclohepta[*b*]indole (20): Yield 85%, 282 mg. Starting material: **17**; Procedure C. TLC (hexane/*i*PrOH, 9:1, R_f = 0.35); HPLC RP-18 (Waters 300 × 3.3, 5 μm; H_2O/CH_3CN, 45:55, flow 1 mL/min, room temp. 4.2 min). M.p. 248 °C (dec.). Racemic mixture. ^{1}H NMR (400 MHz, $[D_3]CD_3CN$): δ = 8.93 (br. s, 1 H, H-1′), 8.30 (s, 1 H, H-5), 7.27 (d, *J* = 8.6 Hz, 1 H, H-7′), 6.97 (d, *J* = 8.4 Hz, 1 H, H-4), 6.90 (d, *J* = 2.5 Hz, 1 H, H-2′), 6.83 (d, *J* = 2.2 Hz, 1 H, H-1), 6.82 (d, *J* = 2.2 Hz, 1 H, H-4′), 6.70 (dd, J_1 = 8.6, J_2 = 2.2 Hz, 1 H, H-6′), 6.53 (dd, J_1 = 8.4, J_2 = 2.2 Hz, 1 H, H-3), 6.34 (br. s, 1 H, 5′-OH), 6.28 (br. s, 1 H, 2-OH), 4.48 (dd, J_1 = 8.6, J_2 = 2.7 Hz, 1 H, H-6), 2.93−2.76 (m, 2 H, H-10), 2.28 (m, 1 H, H-7a), 2.07 (m, 1 H, H-7b), 1.94 (m, 1 H, H-8a), 1.90−1.71 (m, 3 H, H-8b,9) ppm. ^{13}C NMR (100 MHz, $[D_3]CD_3CN$): δ = 151.1 (C-5′), 150.9 (C-2), 141.8 (C-6a), 132.8 (C-7′a), 130.9 (C-1a), 130.2 (C-4a), 128.2 (C-4′a), 124.9 (C-2′), 117.0 (C-3′), 112.9 (C-7′), 112.6 (C-10a), 112.4 (C-6′), 111.8 (C-4), 110.7 (C-3), 104.1 (C-4′), 102.7 (C-1), 38.2 (C-6), 35.2 (C-7), 29.7 (C-8), 29.6 (C-9), 25.3 (C-10) ppm. MS (IS): *m/z* = 333 $[M + H]^+$. $C_{21}H_{20}N_2O_2$ (332.19): calcd. C 75.88, H 6.06, N 8.43; found C 75.00, H 5.96, N 8.03.

2,3-Dihydroxy-4-(1,2-dihydroxyethyl)-1-(1*H*-indol-3-yl)-2,3,4,9-tetrahydro-1*H*-carbazole (21): Yield > 98%, 374 mg. Starting materials: **14−22**; Procedure E. TLC (hexane/*i*PrOH, 75:25, R_f = 0.15); HPLC RP-18 (Waters 250 × 4, 5 μm; H_2O/CH_3CN, 40:60, flow: 1 mL/min, room temp. 2.9 min). M.p. 195 °C (dec.). ^{1}H NMR (400 MHz, $[D_3]CD_3CN$): δ = 9.31 (br. s, 1 H, H-1′), 8.76 (br. s, 1 H, H-9), 7.60 (m, 1 H, H-5), 7.42 (d, *J* = 8.2 Hz, 1 H, H-7′), 7.40 (d, *J* = 8.2 Hz, 1 H, H-4′), 7.18−7.08 (m, 3 H, H-8,2′,6′), 7.05−6.97 (m, 2 H, H-6,7), 6.92 (t, *J* = 8.2 Hz, 1 H, H-5′), 4.39 (dd, J_1 = 8.0, J_2 = 2.2 Hz, 1 H, H-2), 4.33 (d, *J* = 8.0 Hz, 1 H, H-1), 4.28−4.22 (m, 2 H, H-3,2′′), 3.68 (dd, J_1 = 10.7, J_2 = 4.0 Hz, 1 H, H-3′′a), 3.58 (dd, J_1 = 10.7, J_2 = 7.5 Hz, 1 H, H-3′′b), 3.41 (t, J_1 = J_2 = 4.0 Hz, 1 H, H-4) ppm. ^{13}C NMR (100 MHz, $[D_3]CD_3CN$): δ = 138.0 (C-7′a, 8a), 137.3 (C-1a), 128.9 (C-5a), 127.7 (C-3′a), 125.8 (C-2′), 122.4 (C-6′), 121.6 (C-7), 120.2 (C-4′), 120.2 (C-5), 119.7 (C-5′), 119.6 (C-6), 114.6 (C-3′), 112.4 (C-7′), 111.6 (C-8), 107.0 (C-4a), 75.3 (C-3), 73.7 (C-2), 73.2 (C-2′′), 65.5 (C-3′′), 43.8 (C-4), 38.3 (C-1) ppm. MS (IS): *m/z* = 379 $[M + H]^+$. $C_{22}H_{22}N_2O_4$ (378.18): calcd. C 69.80, H 5.86, N 7.40; found C 69.70, H 5.85, N 7.35.

4-(2,2-Dimethyl-1,3-dioxolan-4-yl)-2,3-dihydroxy-1-(1*H*-indol-3-yl)-2,3,4,9-tetrahydro-1*H*-carbazole (22): Yield 30%, 126 mg. Starting material: **14**; Procedure E. TLC (hexane/*i*PrOH, 75:25, R_f = 0.31); HPLC RP-18 (Waters 250 × 4, 5 μm; H_2O/CH_3CN, 40:60, flow: 1 mL/min, room temp. 4.3 min). M.p. 166 °C (dec.). ^{1}H NMR (400 MHz, $[D_3]CD_3CN$): δ = 9.17 (br. s, 1 H, H-1′), 8.60 (br. s, 1 H, H-9), 7.58 (m, 1 H, H-5), 7.36 (d, *J* = 8.1 Hz, 1 H, H-7′), 7.21 (d, *J* = 8.1 Hz, 1 H, H-4′), 7.10 (d, *J* = 2.5 Hz, 1 H, H-2′), 7.07−6.99 (m, 2 H, H-8,6′), 6.95−6.87 (m, 2 H, H-7,6), 6.83 (t, *J* = 8.1 Hz, 1 H, H-5′), 4.45 (m, 1 H, H-4′′), 4.26−4.23 (m, 2 H, H-1,2), 4.07 (dd, J_1 = 8.2, J_2 = 6.2 Hz, 1 H, H-5′′a), 3.93 (d, *J* = 3.0 Hz, 1 H, H-3), 3.78 (t, *J* = 8.2 Hz, 1 H, H-5′′b), 3.30 (dd, J_1 = 7.7, J_2 = 3.0 Hz, 1 H, H-4), 3.20 (br. s, 1 H, 3-OH), 2.98 (br. s, 1 H, 2-OH), 1.35 (s, 3 H, H-6′′a), 1.24 (s, 3 H, H-6′′b) ppm. ^{13}C NMR (100 MHz, $[D_3]CD_3CN$): δ = 138.1 (C-7′a), 137.9 (C-8a), 136.7 (C-1a), 129.0 (C-5a), 127.6 (C-4′a), 125.8 (C-2′), 122.4 (C-6′), 121.7 (C-7), 121.0 (C-5), 120.0 (C-4′), 119.8 (C-5′), 119.6 (C-6), 114.3 (C-3′), 112.5 (C-7′), 111.4 (C-8), 109.6 (C-2′′), 108.2 (C-4a), 79.8 (C-4′′), 73.3 (C-2), 72.6 (C-3), 69.0 (C-5′′), 44.5 (C-4), 38.3 (C-1), 26.9 (C-6′′a), 25.8 (C-6′′b) ppm. MS (IS): *m/z* = 419 $[M + H]^+$. $C_{25}H_{26}N_2O_4$ (418.21): calcd. C 71.75, H 6.26, N 6.69; found C 71.76, H 6.27, N 6.60.

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