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Conformationally Constrained Analogues of Diacylglycerol. 30. An Investigation of Diacylglycerol-lactones Containing Heteroaryl Groups Reveals Compounds with High Selectivity for Ras Guanyl Nucleotide-Releasing Proteins

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Abstract

Using a diacylglycerol-lactone (DAG-lactone) template previously developed in our laboratory as a scaffold with high binding affinity for C1 domains, we describe herein a series of novel DAG-lactones containing heterocyclic moieties (pyridines, quinolines and indoles) as α-arylidene fragments. Some of the DAG-lactones obtained show selective binding to RasGRP3 as compared to PKCα by more than two orders of magnitude and possess subnanomolar affinities. Because activated C1 domains bound to their ligands (DAG or DAG-lactones) insert into membranes, the lipid composition of membranes (cellular, nuclear, and those of internal organelles) are an important determinant for specificity. Therefore, reaching a proper hydrophilic/lipophilic balance for these molecules is critical. This was achieved by carefully selecting partnering acyl fragments for the DAG-lactones with the appropriate lipophilicity. The results clearly show that the combination of chemical and physical properties in these molecules needs to be perfectly balanced to achieve the desired specificity.

Introduction

Protein kinase C was the first enzyme identified as a receptor for the lipophilic second messenger diacylclycerol (DAG).[1] DAG is generated from the hydrolysis of phosphatidylinositol 4,5-bisphosphate catalyzed by phospholipase C isoforms, which become activated by G-protein coupled receptors and by receptor tyrosine kinases.[2] DAG can also be generated indirectly from phosphatidylcholine via phospholipase D.[3] PKCs have always been considered major players in cellular signal transduction involving numerous physiological and pathological processes, including proliferation, differentiation, apoptosis, angiogenesis, and drug resistance.[4] However, the complexity of the different PKCs that are responsive to DAG,

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†Abbreviations: CAN, ceric ammonium nitrate; DAG, diacylglycerol; DAGK, diacylglycerol kinase; DBU, 1,8; diazabicyclo[5.4.0] undec-7-ene; DMAP, 4-dimethylaminopyridine; DMPK, dystrophia myotonica protein kinase; FAB-MS - fast atom bombardment mass spectra; GTP, guanosine triphosphate; IC_{50}, half maximal (50%) inhibitory concentration; LiHMDS, lithium hexamethyldisilazide; MRCK, myotonic dystrophy kinase-related Cdc42-binding kinase; MsCl, methanesulfonyl chloride; NMR, nuclear magnetic resonance; PDBu - [20-^{3}H]phorbol 12,13-dibutyrate; PH, Pleckstrin homology; PKC, protein kinase C; PKD, protein kinase D; RasGRP, Ras guanyl nucleotide-releasing protein; SAR, structure-activity relationship; TBAF, tetra-n-butylammonium fluoride; THF, tetrahydrofuran; TLC, thin layer chromatography

which include the conventional (α, βI, βII, and γ) and novel (δ, ε, η, and θ) isoforms, and their level of differential expression under physiological conditions make it difficult to assign a particular role to each isozyme. Furthermore, the discovery of other DAG-responsive proteins, such as the PKDs, RasGRPs, chimaerins, Munc13s, MRCKs and DAGKs further complicates our understanding of the downstream roles of this widespread second messenger.[5,6] The protein kinase D (PKD/PKCμ) family represents kinases superficially similar to PKC. Interposed between the tandem C1/C2 domains and the catalytic domain of PKD is a PH domain present in many signal transduction proteins which is capable of binding to membrane lipids and other proteins.[7] The Ras guanyl nucleotide-releasing protein family members (RasGRP1-4) function as guanine nucleotide exchange factors for Ras or Rap, leading to their activation, and are also substrates for PKC.[8,9] The chimaerins are GTPase-activating proteins for Rac, leading to Rac inhibition.[10] The Munc13 proteins are involved in the priming of vesicle fusion,[11] and the MRCKs (myotonic dystrophy kinase-related Cdc42-binding kinase) are downstream effectors of Cdc42, which are structurally related to the dystrophia myotonica kinase (DMPK) family, and are involved in actin cytoskeletal reorganization.[12] Finally, the DAGKs (DAG kinases) function to abrogate DAG signaling, thus providing a negative feedback regulatory loop for the DAG signaling pathway.[13]

The major recognition motifs for DAG in PKC and other DAG-responsive proteins are zinc finger structures called C1 domains.[14] These highly conserved structures of ca. 50 amino acids, which bind DAG or the DAG-mimicking phorbol esters, appear in tandem in the novel/classical PKCs and in the PKDs, and as single domains in the chimaerins, RasGRPs, Munc13, and MRCK. X-ray crystallography and NMR analysis, together with molecular modeling, have provided a detailed understanding of the interaction of phorbol esters and DAG with C1 domains.[15–19] The phorbol esters and DAG bind in a hydrophilic cleft in an otherwise hydrophobic surface atop the C1 domain, resulting in membrane translocation and a conformational change that in PKCs removes the pseudosubstrate domain from the catalytic site, thereby activating the enzyme.[15] Strikingly, the affinity of C1 domains for DAG is approximately three orders of magnitude lower than that of the phorbol esters.[20] To help overcome this deficiency, we have developed a conformationally rigid DAG scaffold in the form of a DAG-lactone which, when substituted with an array of side chains designed to achieve an appropriate hydrophobic/hydrophilic balance, provides ligands with strong binding affinities for PKCs.[19] With this strategy, we have generated combinatorial libraries of DAG-lactones that function as potent surrogates of DAG. In these libraries, the nature of the R_1 and R_2 substituents on the DAG-lactone template emerged as the principal determinant in controlling biological activity (see general structures in Tables 1 and 2). For example, switching from simple *n*-alkyl chains to branched alkyl chains or incorporating aromatic moieties at R_1 and/or R_2 produced compounds that in some cases displayed significant degrees of specificity for PKC isozymes and other proteins containing DAG-responsive C1 domains.[21] After the DAG-lactones bind to the C1 domain, these sets of side chains (R_1 and R_2) function as "chemical zip codes", which are capable of interacting with the membrane in the chemical space outside the C1 domain of PKC and other C1-domain containing proteins.[21] Due to the different lipid compositions of plasma membranes, nuclear membranes, and membranes of cellular organelles, such as lysosomes, peroxysomes, mitochondria, endoplastic reticulum, lipid bodies, and Golgi; the interactions between the "chemical zip codes" and the characteristic lipid-water-protein microenvironment outside the C1-domain appear to direct the DAG-lactone–C1-domain complexes to distinct membrane locations producing unique biological responses.[21] This sorting ability of the "chemical zip codes" was demonstrated with {2-(hydroxymethyl)-4-[(4-nitrophenyl)methyene]-5-oxo-2-2,3-dihydrofurfuryl}methyl 4-(dimethylamino)benzoate (**1,** aka **130C032**) and {2-(hydroxymethyl)-4-[(4-nitrophenyl) methyene]-5-oxo-2-2,3-dihydrofurfuryl}methyl 4-methoxybenzoate (**2,** aka **130C037**), which efficiently discriminated between PKCα and RasGRP (both isoforms RasGRP1 and RasGRP3).[22] The selectivity for RasGRP3 over PKCα was 20-fold for **1** and 90-fold for **2**,

respectively (Figure 1).[22] Since according to the proposed binding mode for DAG-lactones[23] the α-arylidene moiety is oriented toward the C1 domain/lipid interface, we decided to explore changes in the *p*-nitrophenyl group of **1** and **2**, beyond the *o*- and *p*-isomers already explored,[21] to enhance even further the discrimination between PKCα and RasGRP. In order to search for different types of interactions, we decided to incorporate for the first time a set of α-heteroarylidene moieties, while leaving the two acyl groups constant as the *p*-dimethylaminophenyl and *p*-methoxyphenyl moieties, respectively (Table 1). Then, the α-heteroarylidene moieties were combined with lipophilic, branched acyl chains to replace the aromatic acyl moieties for optimal activity (Table 2).

Chemistry

As illustrated in Scheme 1, the syntheses of DAG-lactone analogues **12** were completed from racemic lactones (**3** and **4**)[24–26] employing a well-established methodology developed in our laboratory.[26] This involves formation of the aldol intermediates (**5** and **6**) with different aldehydes, followed by elimination of the β-hydroxy lactone intermediate to the corresponding olefin (**7** and **8**), which in most cases generated mixtures of *E*- and *Z*-isomers. Consistent with previously synthesized DAG-lactones, the *E*/*Z* geometry around the double bond was assigned by ^{1}H NMR: the vinyl proton for the *E*-isomers displayed a characteristic multiplet that was farther downfield than that of the corresponding *Z*-isomers. After separation of the geometric *E*/*Z*-isomers, the compounds were individually converted to the corresponding DAG-lactones with different R_1 acyl groups by conventional methods. When the protecting group was the benzyl ether (PG_2 = Bn), debenzylation of intermediates **11** afforded the desired compounds **12**. Because the methylindole moiety was labile to CAN, the syntheses of DAG-lactones where R_2 = methylindole were accomplished starting with **4**[26] with identical twin protecting groups (PG_1 = PG_2 = TBDPS). In this case, olefination of the aldol product (**6**) resulting from the reaction with 1-methylindole-3-carboxaldehyde afforded exclusively the *E*-isomer (**8**). The deprotection of the hydroxyl groups with TBAF (**10**) was followed by selective monoacylation to give directly the expected compounds **12**.

The decision to prepare racemic DAG-lactones was mainly practical, especially when synthesizing a large number of compounds. These compounds are easier to synthesize and in the case of the more potent analogues, which display subnanomolar binding affinities, the differences between enantiomers is minimal as we have shown peviously.[27]

Biological results

The interaction of the target DAG-lactones with PKCα and RasGRP3 was assessed in terms of the ability of the ligands to displace bound [20-^{3}H]phorbol 12,13-dibutyrate (PDBu) from recombinant PKCα and RasGRP3, respectively, in the presence of phosphatidylserine as previously described.[22] The IC_{50} values were determined by fitting the data points to the theoretical competition curve and the K_i values for inhibition of binding were calculated from the corresponding IC_{50} values (Tables 1, 2 and 4). For the biological studies, we selected PKCα as representative of the classical PKCs, which had previously shown the larger difference in SAR relative to the RasGRP isoforms.[22] PKCα has the further advantage that it has been the standard PKC isoform against which all the DAG-latones have routinely been characterized.[19] RasGRP3 and RasGRP1 in previous studies have shown similar SAR.[22] We picked RasGRP3 for the present comparisons because of its emerging role in solid tumors.

Table 1 displays DAG-lactones containing six different types of α-heteroarylidene moieties with either the *p*-dimethylaminophenyl (**12a–f**) or the *p*-methoxyphenyl (**12g–l**) acyl groups characteristic of **2** and **1**, respectively. In the majority of the cases, the geometric isomers were separated and studied individually except when only one isomer was obtained exclusively (compounds **12a**-*E*, **12f**-*E*, and **12l**-*E*). The K_i values in Table 1 for PKCα and RasGRP3

demonstrate, as expected, that none of the compounds had a very good affinity for PKCα, whereas affinity for RasGRP3 was very good, particularly for compounds **12f**-*E* and **12l**-*E*. Another important observation was the large disparities in affinities shown by the two geometrical isomers for both enzymes. In previous studies with DAG-lactones having an α-alkylidene moiety the trend was different, almost always favoring the *Z*-isomer;[19] however, the differences in binding affinities were small, less than 2-fold. Here, for the α-heteroarylidene moieties, not only was the trend reversed but the differences between geometrical isomers appeared as large as 100-fold (for PKCα) and 185-fold (for RasGRP3), always in favor of the *E*-isomer.

Because most of the compounds in Table 1 have log P values in the lower range of 2.0 – 3.5, we decided to replace the aromatic acyl moieties with the more lipophilic branched chain of valproic acid to improve membrane localization (Table 2). The preferred use of branched acyl chains, as opposed to linear *n*-alky chains, has been discussed previously.[19] The changes resulting from the incorporation of valproic acid were very impressive, particularly for RasGRP3. Although affinity for PKCα improved somewhat for all the compounds relative to the values shown in Table 1, the changes were not as dramatic as those observed for RasGRP3 (Table 2) where the affinities were in the low nanomolar range and even reached subnanomolar values for compounds **12m**-*E*, **12q**-*E* and **12r**-*E*. For PKCα, the preferred active isomers were again the *E*-isomers but the differences were in general not as large as those observed in Table 1. On the contrary, for RasGRP3 the differences between geometrical isomers were equal to or even higher than those observed in Table 1, with the exception of two compounds (**12o** and **12p**) where the differences were only 3-fold.

To select the compounds with the highest selectivity for RasGRP3, the K_i ratios for PKCα/RasGRP3 were calculated for all the compounds in Tables 1–2. The results in Table 3 show that the two compounds with the highest selectivities for RasGRP3 are compounds **12m**-*E* and **12r**-*E* with ratios of 119 and 165, respectively. Both compounds were more selective for RasGRP3 than either**1** and **2**.

In earlier studies we have shown that a highly branched acyl chain endows the DAG-lactones with more stability and membrane affinity.[19] Therefore, in an effort to expand even more the difference in affinities between PKCα and RasGRP3, the highly branched chain of 5-methyl-3-(2-methylpropyl)hexanoic acid was employed to modify compounds **12m**-*E* and **12r**-*E*. Unfortunately, despite the fact that the affinity for RasGRP3 remained in the subnanomolar range, the affinity for PKCα was also augmented. Thus, the ratio of 119 displayed by compound **12m**-*E* dropped to 23 for compound **12s**-*E*, and the ratio of 165 for **12r**-*E* plummeted to 21 for compound **12t**-*E* (Table 4).

In conclusion, this work demonstrates that α-heteroarylidene moieties are novel DAG-lactone constituents with the distinct ability to significantly discriminate between a conventional PKC isozyme, represented by the α-isozyme, and another C1 domain-containing protein, RasGRP3. Since this work describes only a minor fraction of a potentially sizeable chemical space that could be explored further with larger sets of DAG-lactones, our findings bode well for the future discovery of compounds capable of differentiating between PKC isozymes and other C1 domain-containing proteins besides RasGRPs. The other significant finding of this work is the importance of the appropriate hydrophilic/lipophilic balance to achieve selectivity. Because the lipid composition of the cellular and nuclear membranes as well as membranes in other intracellular organelles is different, reaching a proper hydrophilic/lipophilic balance seems to be of paramount importance for achieving selectivity. Therefore, the combination of chemical and physical properties in these molecules has to be perfectly balanced. This was demonstrated by the loss of selectivity observed between compounds **12m**-*E* versus **12s**-*E* and between compound **12r**-*E* versus **12t**-*E*, where an increase in 0.88 log P units brought about

by enlarging the acyl group from valproate to 5-methyl-3-(2-methylpropyl)hexanoate abolished all selectivity. Presently, our laboratory is engaged in expanding the chemical and physical domains of novel DAG-lactones with the intent of controlling the makeup of novel DAG-lactones that will show specificity and unique biology.

Experimental section

General Procedures

All chemical reagents were commercially available. [20-^{3}H]phorbol 12,13-dibutyrate (PDBu) was obtained from Perkin-Elmer, Waltham, MA. Melting points were determined on a MelTemp II apparatus, Laboratory Devices, USA, and are uncorrected. Combi-flash column chromatography was performed on silica gel 60 (230–240 mesh) employing a Teledyne Isco instrument, and analytical TLC was performed on Analtech Uniplates silica gel GF. ^{1}H and ^{13}C NMR spectra were recorded on a Varian Unity Inova instrument at 400 and 100 MHz, respectively. Spectra are referenced to the solvent in which they were run (7.26 ppm for $CDCl_3$). Positive-ion fast atom bombardment mass spectra (FABMS) were obtained on a VG 7070E-HF double-focusing mass spectrometer operated at an accelerating voltage of 6 kV under the control of a MASPEC-II data system for Windows (Mass Spectrometry Services, Ltd.). Either glycerol or 3-nitrobenzyl alcohol was used as the sample matrix and ionization was effected by a beam of xenon atoms generated in a saddle-field ion gun at 8.0 ± 0.5 kV. Nominal mass spectra were obtained at a resolution of 1200, and matrix-derived ions were background subtracted during data system processing. Elemental analyses were performed by Atlantic Microlab, Inc., Norcross, GA.

Aldol condensation (Procedure A)

A solution of **3**[24,25] (1 equiv) in THF (5 mL/mmol) at −78 °C was treated dropwise with $[(CH_3)_3Si]_2N$-Li (LiHMDS, 1.5 equiv) and stirred at the same temperature for 2 h. A solution of R_2CHO (1.5 equiv) was added dropwise, and the reaction was stirred at −78 °C (3 to 6 hours). The reaction mixture was then quenched with a saturated aqueous solution of NH_4Cl and allowed to warm to room temperature.

The layers were separated, and the aqueous layer was extracted with Et_2O (3×). The combined organics were washed with H_2O (2×) and brine (1×), dried ($MgSO_4$), and concentrated in vacuo. Purification by silica gel flash column chromatography [hexanes and EtOAc (0% → 75%)] gave **5** as a mixture of diastereomers, which was used directly in the next step.

Olefination (Procedure B)

A solution of **5** (1 equiv) and Et_3N (4 equiv) in CH_2Cl_2 (10 mL/mmol) was treated dropwise with CH_3SO_2Cl (MsCl, 2 equiv) at 0 °C and then stirred at room temperature for 1 h. The reaction mixture was then cooled again to 0 °C and treated dropwise with 1,8-diazabicyclo [5.4.0]non-5-ene (DBU, 5 equiv). When the addition of DBU was completed, the reaction mixture was allowed to reach room temperature overnight. The volatiles were removed in vacuo, and the residue was treated with EtOAc followed by 1 N HCl. The layers were separated, and the aqueous layer was extracted with EtOAc (1 ×). The combined organics were washed with H_2O (2 ×) and brine (1×), dried ($MgSO_4$), and concentrated in vacuo. Purification by silica gel flash column chromatography [hexanes and EtOAc (0% → 75%)] gave **7** as a mixture of *E*- and *Z*-isomers.

7-*E* (R_2 = 2-pyridyl)—Yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.70 (dm, 1H, J = 3.9 Hz, H_6-pyridine), 7.72 (irregular td, 1H, $J \approx$ 8.0, 2.0 Hz, H_3-pyridine), 7.51 (t, 2H, J = 2.9 Hz, C*H*=C), 7.43 (d, 1H, J = 7.7 Hz, H_4-pyridine), 7.21–7.31 (m, 6H, Ph, H_5-pyridine), 6.78–6.83 (m, 4H, $CH_3OC_6H_4$), 4.57–4.63 (AB m, 2H, $PhCH_2OCH_2$), 4.03–4.15 (AB m, 2H,

$CH_3OC_6H_4OCH_2$), 3.68–3.77 (m, 5H, $CH_3OC_6H_4$, $PhCH_2OCH_2$), 3.58 (dd, 1H, *J* = 19.6, 2.8 Hz, CHH-lactone), 3.48 (dd, 1H, *J* = 19.6, 3.0 Hz, CHH-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.45, 154.38, 154.06, 152.71, 150.08, 137.75, 136.59, 133.74, 130.02, 128.52, 127.86, 127.73, 126.95, 123.32, 115.90, 114.71, 84.14, 73.82, 72.29, 70.93, 55.82, 34.23; IR (neat): 1757 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 432.3 (MH^+, 58%), 91.1 (100%); Anal. ($C_{26}H_{25}NO_5$) C, H, N.

7-*Z* (R_2 = 2-pyridyl)—Yellow oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.53 (dm, 1H, *J* = 4.9 Hz, H_6-pyridine), 7.58 (dt, 1H, *J* = 7.6, 1.8 Hz, H_3 *and* H_5-pyridine), 7.23–7.33 (m, 6H, Ph, H_5-pyridine), 7.21 (t, 1H, *J* = 1.5 Hz, CH=C), 7.15 (dd, 1H, *J* = 4.9, 1.1 Hz, H_4-pyridine), 6.74–6.81 (m, 4H, $CH_3OC_6H_4$), 4.54 (AB q, 2H, *J* = 12.0 Hz, $PhCH_2OCH_2$), 4.21 (AB d, 1H, *J* = 10.4 Hz, $CH_3OC_6H_4OCHH$), 4.05 (AB d, 1H, *J* = 10.4 Hz, $CH_3OC_6H_4OCHH$), 3.82 (AB d, 1 H, *J* = 1.4 Hz, $PhCH_2OCH_2$), 3.78 (d, 1H, *J* = 10 Hz, CHH-lactone), 3.75 (s, 3H, $CH_3OC_6H_4$), 3.72 (d, 1H, *J* = 10 Hz, CHH-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.37, 157.26, 154.49, 152.45, 149.22, 137.52, 136.92, 134.04, 128.55, 127.95, 127.75, 123.46, 121.98, 115.92, 114.74, 87.25, 73.91, 70.61, 69.32, 55.81, 34.40; IR (neat): 1760 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 432.3 (MH^+, 81%), 91.1 (100%). This material was used in the next step without further attempts to obtain an analytically pure sample.

7-*E* (R_2 = 3-pyridyl)—Yellow oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.78 (d, 1H, *J* = 1.6 Hz, H_2-pyridine), 8.62 (dd, 1H, *J* = 1.2, 4.8 Hz, H_6-pyridine), 7.83 (dm, 1H, *J* = 8.0 Hz, H_4-pyridine), 7.53 (irregular t, 1H, *J* ≈ 2.8 Hz CH=C), 7.42 (dd, 1H, *J* = 7.9, 4.8 Hz, H_5-pyridine), 7.28–7.33 (m, 5H, Ph), 6.80 (s, 4H, $CH_3OC_6H_4$), 4.60 (s, 2H, $PhCH_2OCH_2$), 4.12 (AB d, 1H, *J* = 10.1 Hz, $CH_3OC_6H_4OCHH$), 4.06 (AB d, 1H, *J* = 10.1 Hz, $CH_3OC_6H_4OCHH$), 3.69–3.76 (m, 5H, $CH_3OC_6H_4$, $PhCH_2OCH_2$), 3.28 (dd, 1H, 17.9, 2.9 Hz, CHH-lactone), 3.21 (dd, 1H, 17.9, 2.9 Hz, CHH-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.54, 153.58, 151.44, 149.28, 148.58, 136.44, 136.22, 131.36, 127.62, 127.15, 127.08, 126.82, 123.12, 114.88, 113.80, 82.52, 72.91, 70.97, 69.80, 54.84, 31.94; IR (neat): 1752 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 432.3 (MH^+, 42%), 91.1 (100%); Anal. ($C_{26}H_{25}NO_5$•$0.6H_2O$) C, H, N.

7-*Z* (R_2 = 3-pyridyl)—Yellow oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.50 (m, 2H, H_2 and H_6-pyridine), 7.55 (dt, 1H, *J* = 7.8, 2.1 Hz, H_4-pyridine), 7.18–7.34 (m, 6H, Ph, H_5-pyridine), 7.04 (t, 1H, *J* = 1.5 Hz, CH=C), 6.73–6.81 (m, 4H, $CH_3OC_6H_4$), 4.53 (AB q, 2H, *J* = 12.0 Hz, $PhCH_2OCH_2$), 4.19 (AB d, 1H, *J* = 11.8 Hz, $CH_3OC_6H_4OCHH$), 4.04 (AB d, 1H, *J* = 11.8 Hz, $CH_3OC_6H_4OCHH$), 3.77 (AB d, 1H, *J* = 12.2 Hz, $PhCH_2OCHH$), 3.75 (s, 3H, OCH_3), 3.68 (AB d, 1H, *J* = 12.2 Hz, $PhCH_2OCHH$), 3.63 (br s, 2H, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.93, 154.53, 152.29, 150.03, 148.93, 137.32, 136.53, 134.86, 132.91, 128.57, 128.03, 127.74, 123.71, 115.85, 114.76, 87.24, 73.90, 70.52, 69.22, 55.77, 29.15; IR (neat): 1758 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 432.3 (MH^+, 100%); Anal. ($C_{26}H_{25}NO_5$•$0.3H_2O$) C, H, N.

7-*E* (R_2 = 4-pyridyl)—Solid: mp 105–106 °C; ^1H NMR (400 MHz, $CDCl_3$): δ 8.66 (m, 2H, H_2 and H_6-pyridine), 7.43 (t, 1H, *J* = 2.9 Hz, CH=C), 7.29–7.31 (m, 2H, H_3 and H_5-pyridine), 7.22–7.28 (m, 5H, Ph), 6.76 (s, 4H, $CH_3OC_6H_4$), 4.55 (s, 2H, $PhCH_2OCH_2$), 4.07 (AB q, 2H, *J* = 9.9 Hz, $CH_3OC_6H_4OCH_2$), 3.70 (s, 3H, $CH_3OC_6H_4$), 3.71 (AB d, 1H, *J* = 10.2 Hz, $PhCH_2OCHH$), 3.67 (AB d, 1H, *J* = 10.2 Hz, $PhCH_2OCHH$), 3.27 (dd, 1H, *J* = 18.1, 2.9 Hz, CHH-lactone), 3.19 (dd, 1H, *J* = 18.1, 2.9 Hz, CHH-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.24, 154.47, 152.30, 150.43, 141.79, 137.33, 133.13, 130.48, 128.51, 127.97, 127.70, 123.52, 115.77, 114.70, 73.76, 71.85, 70.68, 55.70, 32.85; IR (neat): 1751 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 432.2 (MH^+, 100); Anal. ($C_{26}H_{25}NO_5$•$0.3H_2O$) C, H, N.

7-*Z* (R_2 = 4-pyridyl)—Yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.41 (m, 2H, H_2 and H_6-pyridine), 7.18–7.28 (m, 5H, Ph), 7.10 (m, 2H, H_3 and H_5-pyridine), 7.05 (t, 1H, J = 1.4 Hz, C*H*=C), 6.68–6.76 (m, 4H, $CH_3OC_6H_4$), 4.49 (AB q, 2H, J = 12.0 Hz, $PhCH_2OCH_2$), 4.16 (AB d, 1H, J = 9.9 Hz, $CH_3OC_6H_4OCHH$), 4.00 (AB d, 1H, J = 9.9 Hz, $CH_3OC_6H_4OCHH$), 3.76 (AB d, 1H, J = 9.9 Hz, $PhCH_2OCHH$), 3.70 (s, 3H, $CH_3OC_6H_4$), 3.66 (d, 1H, J = 9.9 Hz, $PhCH_2OCHH$), 3.58 (br s, 2H, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.88, 154.58, 152.25, 150.56, 149.50, 146.73, 137.26, 133.79, 128.61, 128.58, 128.12, 127.80, 127.77, 124.19, 123.56, 115.82, 114.79, 114.76, 113.58, 87.35, 73.98, 70.54, 69.26, 55.78, 31.17; IR (neat): 1758 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 432.1 (MH^+, 100). Anal. ($C_{26}H_{25}NO_5$) C, H, N.

7-*E* (R_2 = 2-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.18 (d, 1H, J = 8.4 Hz, H_4-quinoline), 8.12 (d, 1H, J = 8.4 Hz, H_5-quinoline), 7.82 (dm, 1H, J = 8.2 Hz, H_8-quinoline), 7.73 (m, 2H, H_7-quinoline), 7.68 (t, 1H, J = 3.1 Hz, C*H*=C), 7.56 (dm, 1H, H_6-quinoline), 7.53 (d, 1H, J = 8.4 Hz, H_3-quinoline), 7.25–7.31 (m, 5H, Ph), 6.78–6.85 (m, 4H, $CH_3OC_6H_4$), 4.62 (AB m, 2H, $PhCH_2OCH_2$), 4.15 (AB m, 2H, $CH_3OC_6H_4OCH_2$), 3.78 (s, 2H, $PhCH_2OCH_2$), 3.69–3.74 (m, 4H, $CH_3OC_6H_4$, C*H*H-lactone), 3.66 (dd, 1H, J = 19.9, 3.1, Hz, CH*H*-lactone); ^{13} C NMR (100 MHz, $CDCl_3$): δ 171.34, 154.40, 154.02, 152.75, 148.46, 137.75, 136.58, 133.73, 131.58, 130.09, 130.00, 128.54, 127.88, 127.76, 127.67, 127.47, 127.35, 123.96, 115.96, 114.73, 84.31, 73.85, 72.31, 71.01, 55.82, 34.55; IR (neat): 1755 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 482.5 (MH^+, 100%); Anal. ($C_{30}H_{27}NO_5$) C, H, N.

7-*Z* (R_2 = 2-quinolinyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.06 (d, 1H, J = 8.5 Hz, H_4-quinoline), 8.03 (d, 1H, J = 8.5 Hz, H_5-quinoline), 7.80 (d, 1H, J = 8.0 Hz, H_8-quinoline), 7.71 (m, 1H, Hz, H_7-quinoline), 7.52 (m, 1H, H_6-quinoline), 7.36 (d, 1H, J = 8.5 Hz, H_3-quinoline), 7.21–7.28 (m, 6H, , Ph, C*H*=C), 6.72–6.78 (m, 4H, $CH_3OC_6H_4$), 4.54 (AB q, 2H, J = 12.0 Hz, $PhCH_2OCH_2$), 4.22 (dm, 1H, J = 9.8 Hz, $CH_3OC_6H_4OCHH$), 4.06 (dm, 1H, J = 9.8 Hz, $CH_3OC_6H_4OCHH$), 4.02 (br s, 2H, $PhCH_2OCH_2$), 3.79 (dm, 1H, J = 10.2 Hz, C*H*H-lactone), 3.74 (s, 3H, $CH_3OC_6H_4$), 3.72 (dm, 1H, J = 10.2 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.26, 157.55, 154.32, 152.27, 149.44, 137.31, 136.96, 133.72, 129.67, 128.83, 128.37, 127.79, 127.59, 127.55, 126.94, 126.30, 121.40, 115.77, 114.56, 87.23, 73.75, 70.44, 69.18, 55.64, 34.88; IR (neat): 1758 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 482.7 (MH^+, 100%); Anal. ($C_{30}H_{27}NO_5$) C, H, N.

7-*E* (R_2 = 3-quinolyl)—Yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ9.04 (d, 1H, J = 2.2 Hz, H_2-quinoline), 8.23 (br d, 1H, J = 1.9 Hz, H_4-quinoline), 8.13 (d, 1H, J = 8.4 Hz, H_5-quinoline), 7.88 (dm, 1H, J = 8.4 Hz, H_8-quinoline), 7.77 (m, 1H, H_7-quinoline), 7.71 (t, 1H, J = 2.9 Hz, C*H*=C), 7.60 (m, 1H, H_6-quinoline), 7.24–7.32 (m, 5H, Ph), 6.78–6.83 (m, 4H, $CH_3OC_6H_4$), 4.60 (s, 2H, $PhCH_2OCH_2$), 4.11 (AB q, 2H, J = 9.9 Hz, $CH_3OC_6H_4OCH_2$), 3.75 (AB q, 2H, J = 10.2 Hz, $CH_3OC_6H_4OCH_2$), 3.74 (s, 3H, $CH_3OC_6H_4$), 3.39 (dd, 1H, J = 17.8, 2.9 Hz, C*H*H-lactone), 3.31 (dd, 1H, J = 2.9, 17.8 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.74, 154.52, 152.46, 151.14, 147.96, 137.44, 136.83, 132.90, 131.01, 129.45, 128.59, 128.51, 128.03, 127.28, 127.80, 127.64, 127.47,115.87, 114.77, 83.47, 73.89, 71.99, 70.81, 55.79, 33.07, 31.63; IR (neat): 1751 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 482.1 (MH^+, 100%). This material was used in the next step without further attempts to obtain an analytically pure sample.

7-*Z* (R_2 = 3-quinolyl)—Yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ9.00 (s, 2H, H_2 and H_4-quinoline), 8.08 (d, 1H, J = 8.4 Hz, H_5-quinoline), 7.89 (dd, 1H, J = 8.4, 1.1 Hz, H_8-quinoline), 7.74 (m, 1H, H_7-quinoline), 7.56 (m, 1H, H_6-quinoline), 7.27–7.32 (m, 5H, Ph), 7.09 (t, 1H, J = 2.4 Hz, C*H*=C), 6.75–6.82 (m, 4H, $CH_3OC_6H_4$), 4.62 (AB m, 2H, $PhCH_2OCH_2$), 4.11 (AB q, 2H, J = 9.9 Hz, $CH_3OC_6H_4OCH_2$), 3.70–3.83 (m, 5H, $CH_3OC_6H_4OCH_2$, $CH_3OC_6H_4$), 3.27

(dd, 1H, *J* = 17.2, 2.4 Hz, C*H*H-lactone), 3.21 (dd, 1H, *J* = 17.2, 2.4 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.84, 154.54, 152.58, 152.21, 147.93, 137.77, 137.62, 135.56, 130.59, 129.27, 129.00, 128.63, 128.05, 127.82, 127.80, 127.53, 127.07, 126.85, 115.86, 114.84, 82.87, 73.96, 72.13, 70.77, 55.87, 36.11, IR (neat): 1755 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 482.4 (MH^+, 100%). Anal. ($C_{30}H_{27}NO_5$) C, H, N.

General Procedure for the Synthesis of 9

Ceric ammonium nitrate (CAN, 3 equiv) was added to a stirring solution of **7** (1 equiv) in acetonitrile (8 mL/mmol of III) and water (2 mL/mmol of **7**) at 0 °C. The reaction was monitored by TLC, quenched after 30 min with a saturated aqueous $NaHCO_3$ solution and warmed to room temperature. The resulting aqueous solution was extracted with EtOAc (3 ×), dried ($MgSO_4$), and concentrated in vacuo. Purification by silica gel flash column chromatography [CH_2Cl_2-MeOH (0% → 10%)] gave intermediate 9.

9-*E* (R_2 = 2-pyridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.67 (dm, 1H, *J* = 4.3 Hz, H_6-pyridine), 7.70 (td, 1H, *J* = 7.7, 1.8 Hz, H_4-pyridine), 7.46 (t, 1H, *J* = 3.0 Hz, C*H*=C), 7.40 (d, 1H, *J* = 7.8 Hz, H_5-pyridine), 7.20–7.31 (m, 6H, Ph, H_3-pyridine), 4.55 (s, 2H, PhCH_2OCH_2), 3.84 (AB d, 1H, *J* = 12.1 Hz, HOC*H*H), 3.72 (AB d, 1H, *J* = 12.1 Hz, HOCH*H*), 3.63 (s, 2H, PhCH_2OCH_2), 3.40 (dd, 1H, *J* = 19.6, 3.0 Hz, C*H*H-lactone), 3.36 (dd, 1H, *J* = 19.6, 3.0 Hz, C*H*H-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.70, 153.95, 150.02, 137.69, 136.58, 133.85, 130.22, 128.49, 127.85, 127.69, 126.85, 123.33, 85.56, 73.77, 72.17, 65.65, 33.57; IR (neat): 3412 (OH), 1746 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 326.2 (MH^+, 97 %), 91.1 (100%); Anal. ($C_{19}H_{19}NO_4$) C, H, N.

9-*Z* (R_2 = 2-pyridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$/CD_3OD): δ 8.55 (d, 1H, *J* = 4.8 Hz, H_6-pyridine), 7.88 (t, 1H, *J* = 7.8, Hz, H_4-pyridine), 7.56 (d, 1H, *J* = 7.8 Hz, H_3-pyridine), 7.50 (irregular t, 1H, *J* ≈ 6.3 Hz, H_5-pyridine), 7.34 (s, 1H, C*H*=C), 7.16–7.26 (m, 5H, Ph), 4.42 (AB s, 2H, PhCH_2OCH_2), 3.95 (s, 2H, CH_2OH), 3.74 (AB q, 2H, *J* = 12.0 Hz, PhCH_2OCH_2), 3.66 (AB q, 2H, *J* = 10.4 Hz, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$/CD_3OD): δ 172.58, 153.98, 152.61, 144.12, 143.44, 137.33, 130.40, 128.43, 127.88, 127.76, 126.39, 124.23, 90.29, 73.80, 70.06, 62.64, 30.81; IR (neat): 3420 (OH), 1751 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 326.1 (MH^+, 100%); Anal. ($C_{19}H_{19}NO_4$) C, H, N.

9-*E* (R_2 = 3-pyridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.71 (d, 1H, *J* = 1.7 Hz, H_2-pyridine), 8.56 (dd, 1H, *J* = 4.8, 1.3 Hz, H_6-pyridine), 7.77 (dt, 1H, *J* = 8.0, 1.8 Hz, H_4-pyridine), 7.44 (t, 1H, *J* = 2.9 Hz, C*H*=C), 7.34 (dd, 1H, *J* = 8.0, 4.8 Hz, H_5-pyridine), 7.21–7.30 (m, 5H, Ph), 4.53 (s, 2H, PhCH_2OCH_2), 3.84 (AB d, 1H, *J* = 12.2 Hz, HOC*H*H), 3.72 (AB d, 1H, *J* = 12.2 Hz, HOCH*H*), 3.60 (s, 2H, PhCH_2OCH_2), 3.20 (dd, 1H, *J* = 17.8, 2.9 Hz, C*H*H-lactone), 3.12 (dd, 1H, *J* = 17.8, 2.9 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.10, 150.81, 150.02, 137.47, 136.75, 132.47, 130.82, 128.54, 128.27, 127.97, 127.70, 123.88, 85.22, 73.77, 71.89, 65.09, 32.27; IR (neat): 3060 (OH), 1745 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 326.2 (MH^+, 100%); Anal. ($C_{19}H_{19}NO_4$) C, H, N.

9-*Z* (R_2 = 3-pyridyl)—white solid, m.p.:146–147°C; ^{1}H NMR (400 MHz, $CDCl_3$/CD_3OD): δ 8.54–8.66 (br doublets, 2H, H_2 and H_6-pyridine), 8.02 (d, 1H, *J* = 7.9 Hz, H_4-pyridine), 7.50 (br s, 1H, H_5-pyridine), 7.20–7.31 (m, 6H, Ph, C*H*=C), 4.48 (AB q, *J* = 12.0 Hz, 1H, PhCH_2OCH_2), 3.71–3.81 (m, 4H, HOCH_2, PhCH_2OCH_2), 3.66 (AB q, 2 H, *J* = 10.3 Hz, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$/CD_3OD): δ 172.71, 151.89, 145.06, 142.77, 141.00, 137.30, 131.90, 128.42, 127.88, 127.68, 126.50, 126.48, 90.21, 73.74, 70.17, 62.46, 28.49; IR (neat): 3376 (OH), 1752 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 326.1 (MH^+, 100%); Anal. ($C_{19}H_{19}NO_4$•0.2H_2O) C, H, N.

9-*E* (R_2 = 4-pyridyl)—white solid; m.p.: 144–145°C; ^{1}H NMR (400 MHz, DMSO- d_6): δ 8.67 (m, 2H, H_2 and H_6-pyridine), 7.56 (m, 2H, H_3 and H_5-pyridine), 7.34 (t, 1H, J = 2.9 Hz, C*H*=C), 7.23–7.31 (m, 5H, Ph), 5.25 (t, 1H, J = 5.8 Hz, *H*OCH$_2$), 4.52 (s, 2H, PhCH_2OCH$_2$), 3.52–3.66 (m, 4H, PhCH$_2$OCH_2, HOCH_2), 3.20 (dd, 1H, J = 18.4, 2.9 Hz, C*H*H-lactone), 3.12 (dd, 1H, J = 18.4, 2.9 Hz, C*H*H-lactone); ^{13}C NMR (100 MHz, DMSO-d_6): δ 170.33, 150.29, 150.26, 141.52, 137.97, 132.34, 130.91, 130.85, 128.24, 127.48, 127.25, 123.58, 123.55, 85.73, 72.53, 71.75, 63.43, 31.90; IR (neat): 3144 (OH), 1745 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 326.2 (MH$^+$, 100%); Anal. ($C_{19}H_{19}NO_4$•0.3H_2O) C, H, N.

9-*Z* (R_2 = 4-pyridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.40 (m, 2H, H_2 and H_6-pyridine), 7.23–7.34 (m, 5H, Ph), 7.14 (m, 2H, H_3 and H_5-pyridine), 7.04 (t, 1H, J = 1.4 Hz, C*H*=C), 4.51 (AB q, 2H, J = 11.9 Hz, PhCH_2OCH$_2$), 3.82 (AB q, 2H, J = 12.0 Hz, HOCH_2), 3.74 (d, 1H, J = 10.0 Hz, PhCH$_2$OC*H*H), 3.60–3.63 (overlapped d and br s, 3H, PhCH$_2$OCH*H*, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.36, 150.22, 149.54, 147.06, 137.34, 133.50, 128.61, 128.11, 127.78, 124.32, 89.23, 73.96, 70.48, 63.63, 31.17; IR (neat): 3316 (OH), 1754 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 326.1 (MH$^+$, 100%); Anal. ($C_{19}H_{19}NO_4$•0.2H_2O) C, H, N.

9-*E* (R_2 = 2-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.18 (d, 1H, J = 8.4 Hz, H_4-quinoline), 8. 11 (d, 1H, J = 8.4 Hz, H_5-quinoline), 7.82 (dm, 1H, J = 8.4 Hz, H_8-quinoline), 7.73 (m, 1H, H_7-quinoline), 7.65 (t, 1H, J = 3.1 Hz, C*H*=C), 7.55 (m, 1H, H_6-quinoline), 7.51 (d, 1H, J = 8.4 Hz, H_3-quinoline), 7.25–7.30 (m, 5H, Ph), 4.59 (s, 2H, PhCH_2OCH$_2$), 3.90 (AB d, 1H, J = 12.2 Hz, HOC*H*H), 3.79 (AB d, 1H, J = 12.2 Hz, HOCH*H*), 3.67 (s, 2H, PhCH$_2$OCH_2), 3.65 (dd, 1H, J = 19.8, 3.1 Hz, C*H*H-lactone), 3.55 (dd, 1H, J = 19.8, 3.1 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.39, 153.81, 137.68, 137.42, 130.27, 129.80, 128.61, 128.57, 127.95, 127.83, 127.78, 127.70, 127.65, 127.40, 123.86, 85.66, 73.97, 73.86, 72.17, 65.83, 33.07; ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.39, 153.81, 137.68, 137.42, 130.27, 129.80, 128.61, 128.57, 127.95, 127.83, 127.78, 127.70, 127.65, 127.40, 123.86, 85.66, 73.97, 73.86, 72.17, 65.83, 33.95; IR (neat): 3348 (OH), 1754 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 376.1 (MH$^+$, 100%). This material was used in the next step without further attempts to obtain an analytically pure sample.

9-*Z* (R_2 = 2-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.47 (d, 1H, J = 8.4 Hz, H_4-quinoline), 8.36 (d, 1H, J = 8.4 Hz, H_5-quinoline), 7.96 (d, 1H, J = 8.3 Hz, H_8-quinoline), 7.92 (irregular t. 1H, $J \approx$ 7.7 Hz, H_7-quinoline), 7.81 (d, 1H, J = 8.4 Hz, H_6-quinoline), 7.74 (t, 1H, J = 7.6 Hz, H_3-quinoline), 7.61 (br s, 1H, C*H*=C), 7.19–7.27 (m, 5H, Ph), 4.45 (s, 2H, PhCH_2OCH$_2$), 4.32 (AB q, 2H, J = 15.8 Hz, HOCH_2), 3.83 (AB q, 2H, J = 12.0 Hz, PhCH$_2$OCH_2), 3.73 (AB q, 2H, J = 10.5 Hz, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.26, 155.98, 154.00, 146.01, 138.58, 137.51, 134.81, 129.26, 128.57, 128.55, 128.53, 127.92, 127.90, 127.51, 122.93, 121.51, 90.66, 73.89, 70.21, 62.96, 30.69; FAB-MS (m/z, relative intensity) 376.1 (MH$^+$, 100%). This material decomposed on standing and was not analyzed.

9-*E* (R_2 = 3-quinolyl)—with solid, m.p.:138–139°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.02 (d, 1H, J = 2.2 Hz, H_2-quinoline), 8.23 (d, 1H, J = 2.0 Hz, H_4-quinoline), 8.11 (d, 1H, J = 8.4 Hz, H_5-quinoline), 7.85 (dm, 1H, J = 8.2 Hz, H_8-quinoline), 7.76 (m, 1H, H_7-quinoline), 7.64 (t, 1H, J = 2.9 Hz, C*H*=C), 7.59 (m, 1H, H_6-quinoline), 7.22–7.31 (m, 5H, Ph), 4.56 (s, 2H, PhCH_2OCH$_2$), 3.91 (AB d, 1H, J = 12.2 Hz, HOC*H*H), 3.81 (AB d, 1H, J = 12.2 Hz, HOCH*H*), 3.68 (AB q, 2H, J = 10.2 Hz, PhCH$_2$OCH_2), 3.33 (dd, 1H, J = 17.8, 2.9 Hz, C*H*H-lactone), 3.33 (dd, 1H, J = 17.8, 2.9 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.18, 151.08, 147.76, 137.46, 137.00, 132.84, 132.85, 131.06, 129.25, 128.58, 128.50, 128.02, 127.94, 127.78, 127.66, 85.15, 73.85, 71.96, 65.26, 32.49; IR (neat): 3420 (OH), 1745 (CO)

cm^{-1}; FAB-MS (m/z, relative intensity) 376.4 (MH^+, 100%); Anal. ($C_{23}H_{21}NO_4 \cdot 0.3H_2O$) C, H, N.

9-*Z* (R_2 = 3-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ8.82 (d, 1H, *J* = 1.7 Hz, H_2-quinoline), 8.12 (d, 1 H, *J* = 8.4 Hz, H_5-quinoline), 8.08 (d, 1H, *J* = 1.7 Hz, H_4-quinoline), 7.68–7.74 (m, 2H, H_7 and H_8-quinoline), 7.54 (m, 1H, H_6-quinoline), 7.22–7.31 (m, 5H, Ph), 7.07 (t, 1H, *J* = 1.4 Hz, C*H*=C), 4.52 (AB q, 2H, *J* = 12.0 Hz, PhCH_2OCH_2), 3.83 (AB q, 2H, *J* = 12.0 Hz, HOCH_2), 3.80 (br s, 2 H, PhCH_2OCH_2), 3.73 (AB d, 1H, *J* = 10.0 Hz, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.37, 150.56, 150.04, 145.70, 137.35, 137.02, 134.33, 130.41, 130.20, 130.16, 128.63, 128.22, 128.10, 127.81, 127.77, 127.54, 89.11, 73.97, 70.53, 63.78, 29.39; IR (neat): 3450 (OH), 1738 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 376.1 (MH^+, 100%); Anal. ($C_{23}H_{21}NO_4 \cdot 0.8H_2O$) C, H, N.

General Procedure for the Synthesis of 11

A solution of 9 (1 equiv) in CH_2Cl_2 (12 mL/mmol) was treated with Et_3N (3 equiv), R_1COCl (1.5 equiv), and a catalytic amount of DMAP (0.1 equiv). The reaction was stirred at room temperature and monitored by TLC. Upon completion, the reaction was concentrated in vacuo and purified by silica gel flash column chromatography [hexanes-EtOAc (0% → 75%)] to give **11**.

11-*E* (R_1 = 4-$(CH_3)_2NC_6H_4$, R_2 = 2-pyridyl)—colorless oil; ^{1} H NMR (400 MHz, $CDCl_3$): δ 8.68 (dm, 1H, *J* = 4.8 Hz, H_6-pyridine), 7.79 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 7.70 (td, 1H, *J* = 7.7, 1.9 Hz, H_4-pyridine), 7.50 (t, 1H, *J* = 3.0 Hz, C*H*=C), 7.40 (d, 1H, *J* = 7.8 Hz, H_3-pyridine), 7.20–7.30 (m, 6H, Ph, H_5-pyridine), 6.57 (m, 2H, $(CH_3)_2$N $C_6H_4CO_2$), 4.62 (s, 2H, PhCH_2O), 4.48 (AB m, 2H, CO_2CH_2), 3.72 (AB m, 2H, PhCH_2OCH_2), 3.56 (dd, 1H, *J* = 19.6, 3.0 Hz, C*H*H-lactone), 3.52 (dd, 1H, *J* = 19.6, 3.0 Hz, CH*H*-lactone), 3.01 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.43, 166.39, 153.95, 153.55, 150.11, 137.63, 136.53, 133.70, 131.58, 129.95, 128.52, 127.87, 127.73, 126.87, 123.32, 116.11, 110.77, 83.87, 73.85, 72.23, 66.00, 40.13, 34.29; IR (neat): 1754 (CO), 1701 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 473.2 (MH^+, 41%), 148.1 (MH^+, 100%); Anal. ($C_{28}H_{28}N_2O_5$) C, H, N

11-*E* (R_1 = 4-$(CH_3)_2NC_6H_4$, R_2 = 3-pyridyl)—colorless oil; ^{1} H NMR (400 MHz, $CDCl_3$): δ 8.70 (d, 1H, *J* = 2.0 Hz, H_2-pyridine), 8.58 (dd, 1H, *J* = 4.8. 1.4 Hz, H_6-pyridine), 7.72–7.77 (m, 3H, H_4-pyridine, $(CH_3)_2NC_6H_4CO_2$), 7.51 (t, 1H, *J* = 2.9 Hz, C*H*=C), 7.34 (dd, 1H, *J* = 8.0, 4.8 Hz, H_5-pyridine), 7.26–7.30 (m, 5H, Ph), 6.56 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.59 (AB q, 2H, *J* = 12.1 Hz, PhCH_2O), 4.52 (AB d, *J* = 12.1 Hz, 1H, CO_2CHH), 4.42 (AB d, *J* = 12.1 Hz, 1H, CO_2CHH), 3.73 (AB d, 1H, *J* = 10.2 Hz, PhCH_2OC*H*H), 3.71 (AB q, 2H, *J* = 10.2 Hz, PhCH_2OCH_2), 3.24 (dd, 1H, *J* = 17.8, 2.9, Hz, C*H*H-lactone), 3.14 (dd, 1H, *J* = 17.8, 2.9 Hz, C*H*H-lactone), 3.01 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.56, 166.24, 153.63, 151.15, 150.33, 137.32, 136.23, 132.62, 131.54, 130.56, 128.58, 128.04, 127.79, 127.63, 123.78, 115.64, 110.75, 83.26, 73.88, 71.83, 65.75, 40.09, 33.03; IR (neat) 1753 (CO), 1700 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 473.3 (MH^+, 36%), 148.1 (MH^+, 100%); Anal. ($C_{28}H_{28}N_2O_5 \cdot 0.3H_2O$) C, H, N.

11-*Z* (R_1 = 4-$(CH_3)_2NC_6H_4$, R_2 = 3-pyridyl)—colorless oil; ^{1} H NMR (400 MHz, $CDCl_3$): δ 8.40–8.42 (m, 2H, H_2 and H_6-pyridine), 7.71 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 7.37 (dt, 1H, *J* = 6.1, ~1.9 Hz, H_4-pyridine), 7.21–7.31(m, 5H, Ph), 7.04 (ddd, 1H, *J* = 4.9, 3.0, ~0.7 Hz, H_5-pyridine), 6.90 (t, 1H, *J* = 1.5 Hz, C*H*=C), 6.56 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.65 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH) 4.51 (AB q, 2H, *J* = 12.0 Hz, PhCH_2O), 4.36 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 3.71 (AB d, 1H, *J* = 10.1 Hz, PhCH_2OCH*H*), 3.60 (AB d, 1H, *J* = 10.1 Hz, PhCH_2OC*H*H), 3.51 (br s, 2H, CCH_2-lactone), 3.01 (s, 3H, $(CH_3)_2NC_6H_4$); ^{13}C NMR

(100 MHz, $CDCl_3$): δ 171.93, 166.12, 153.69, 149.89, 148.27, 148.13, 137.19, 136.54, 135.00, 132.77, 131.51, 128.62, 128.09, 127.81, 123.72, 115.63, 110.85, 87.45, 73.97, 70.69, 63.01, 40.13, 29.11; IR (neat): 1755 (CO), 1702 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 473.2 (MH^+, 95%), 148.1 (MH^+, 100%); Anal. ($C_{28}H_{28}N_2O_5$•0.1H_2O) C, H, N.

11-*E* R_1 = 4-$(CH_3)_2NC_6H_4$, R_2= 4-pyridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.62 (br d, 2H, *J* = 6.0 Hz, H_2 and H_6-pyridine), 7.70 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 7.38 (t, 1H, *J* = 2.9 Hz, C*H*=C), 7.22–7.25 (m, 7H, Ph, H_3 and H_5-pyridine), 6.52 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.53 (AB q, 2H, *J* = 11.8 Hz, PhCH_2O), 4.50 (AB d, 1H, *J* = 12.0 Hz, CO_2CH*H*), 4.37 (AB d, 1H, *J* = 12.0 Hz, CO_2CH*H*), 3.67 (AB m, 2H, *J* = $PhCH_2OCH_2$), 3.21 (dd, 1H, *J* = 18.0, 2.9 Hz, C*H*H-lactone), 3.12 (dd, 1H, *J* = 18.0, 2.9 Hz, C*H*H-lactone), 2.98 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.17, 166.19, 153.65, 149.90, 142.31, 137.24, 132.88, 131.55, 130.90, 128.59, 128.07, 127.80, 123.65, 115.52, 110.74, 83.59, 73.89, 71.72, 65.62, 40.09, 33.03; IR (neat): 1762 (CO), 1703 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 473.2 (MH^+, 73%), 148.1 (MH^+, 100%); Anal. ($C_{28}H_{28}N_2O_5$•0.5H_2O).

11-*Z* (R_1 = 4-$(CH_3)_2NC_6H_4$, R_2 = 4-pyridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.32 (br d, *J* = 6.0 Hz, 2H, H_2 and H_6-pyridine), 7.74 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 7.27- 7.36 (m, 5H, Ph), 7.07 (br d, 2H, *J* = 6.0 Hz, H_3 and H_5-pyridine), 7.05 (t, 1H, *J* = 1.4 Hz, C*H*=C), 6.59 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.78 (AB d, 1H, *J* = 11.9 Hz, CO_2C*H*H), 4.55 (AB q, 2H, *J* = 11.9 Hz, PhCH_2O), 4.38 (AB d, 1H, *J* = 11.9 Hz, CO_2CH*H*), 3.77 (AB d, 1H, *J* = 10.1 Hz, $PhCH_2OCHH$), 3.67 (AB d, 1H, *J* = 10.1 Hz, $PhCH_2OCHH$), 3.58 (br s, 2H, CH_2-lactone), 2.98 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.85, 166.21, 153.81, 149.17, 148.66, 137.15, 133.54, 131.58, 128.70, 128.24, 127.91, 124.43, 115.40, 110.91, 110.85, 87.76, 74.11, 70.79, 62.88, 40.20, 31.29; IR (neat): 1759 (CO), 1698 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 473.2 (MH^+, 100%); Anal. ($C_{28}H_{28}N_2O_5$) C, H, N.

11-*E* (R_1 = 4-$(CH_3)_2NC_6H_4$, R_2 = 2-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.13 (d, 1H, *J* = 8.4 Hz, H_4-quinoline), 8.07 (d, 1H, *J* = 8.4 Hz, H_5-quinoline), 7.80 (m, 3H, $(CH_3)_2NC_6H_4CO_2$, H_8-quinoline), 7.69 (m, 1H, H_7-quinoline), 7.64 (t, 1H, *J* = 3.0 Hz, C*H*=C), 7.52 (m, 1H, H_6-quinoline), 7.47 (d, 1H, *J* = 8.4 Hz, H_3-quinoline), 7.20–7.28 (m, 5H, Ph), 6.53 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.58 (s, 2H, PhCH_2O), 4.49(AB q, 2H, *J* = 12.00 Hz, CO_2CH_2), 3.61–3.78 (overlapping AB q and dd, 3H, *J* = 10.2 and 19.8, 3.0 Hz, $PhCH_2OCH_2$ and C*H*H-lactone), 3.60 (dd, 1 H, *J* = 19.8, 3.0 Hz, CH*H*-lactone), 3.01 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.35, 166.45, 153.93, 153.59, 148.48, 137.64, 136.55, 133.70, 131.62, 131.53, 130.17, 130.03, 128.56, 127.91, 127.79, 127.63, 127.49, 127.35, 123.86, 116.12, 110.80, 84.08, 73.89, 72.23, 66.08, 40.15, 34.62; IR (neat): 1759 (CO), 1701 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 523.3 (MH^+, 40%), 148.1 (MH^+, 100%); Anal. ($C_{32}H_{30}N_2O_5$•0.1H_2O) C, H, N.

11-*Z* (R_1 = 4-$(CH_3)_2NC_6H_4$, R_2 = 2-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.02 (br d, 1H, *J* = 8.4 Hz, H_4-quinoline), 7.94 (d, 1H, *J* = 8.4 Hz, H_5-quinoline), 7.73–7.77 (m, 4H, $(CH_3)_2NC_6H_4CO_2$, H_7 and H_8-quinoline), 7.51 (m, 1H, *J* = H_6-quinoline), 7.20–7.31 (m, 7H, Ph, H_3-quinoline, C*H*=C), 6.50 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.66 (AB d, 1H, *J* = 11.8 Hz, CO_2C*H*H), 4.56 (AB q, 2H, *J* = 12.0 Hz, PhCH_2O), 4.45 (AB d, 1H, *J* = 11.8 Hz, CO_2CH*H*), 3.98 (br s, 2H, $PhCH_2OCH_2$), 3.77 (AB d, 1H, *J* = 10.1 Hz, $C_6H_5CH_2OCHH$), 3.66 (AB d, 1H, *J* = 10.1 Hz, $C_6H_5CH_2OCHH$) 3.02 (s, 6H, N $(CH_3)_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.39, 166.09, 157.44, 153.57, 149.35, 149.33, 137.30, 133.74, 131.50, 130.02, 128.62, 128.57, 128.00, 127.84, 127.80, 127.66, 127.07, 126.57, 121.50, 115.81, 110.74, 87.50, 73.78, 70.86, 63.18, 40.14, 34.69; IR (neat): 1762 (CO), 1703 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 523.2 (MH^+, 87%), 148.1 (MH^+, 100%).

This material was used in the next step without further attempts to obtain an analytically pure sample.

11-*E* (R_1 = 4-$(CH_3)_2NC_6H_4$, R_2 = 3-quinolyl)—yellow solid, m.p: 146–147°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.94 (br d, 1H, *J* = 1.7 Hz, H_2-quinoline), 8.14 (br d, 1H, *J* = 1.8 Hz, H_4-quinoline), 8.07 (d, 1H, *J* = 8.4 Hz, H_5-quinoline), 7.82 (dm, 1H, *J* = 8.4 Hz, H_8-quinoline), 7.71–7.75 (m, 3H, H_7-quinoline, $(CH_3)_2NC_6H_4CO_2$), 7.64 (br t, 1H, *J* = 2.9 Hz, C*H*=C), 7.56 (m, 1H, H_6-quinoline), 7.20–7.29 (m, 5H, Ph), 6.51 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.57 (AB m, 2H, $PhCH_2OCH_2$), 4.53 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.41 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 3.78 (AB q, 2H, *J* = 10.1 Hz, $C_6H_5CH_2OCH_2$), 3.32 (dd, 1H, *J* = 17.8, 2.9 Hz, C*H*H-lactone), 3.22 (dd, 1H, *J* = 17.8, 2.9 Hz, C*H*H-lactone), 2.96 (s, 3H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.68, 166.26, 153.60, 151.19, 147.98, 137.32, 136.58, 132.74, 131.53, 130.95, 129.43, 128.59, 128.50, 128.03, 127.82, 127.58, 127.49, 115.63, 110.73, 83.33, 73.91, 71.86, 65.79, 40.07, 33.20; IR (neat): 1752 (CO), 1699 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 523.5 (MH^+, 75%), 148.2 (MH^+, 100%); Anal. ($C_{32}H_{30}N_2O_5$•$0.5H_2O$) C, H, N.

11-*Z* (R_1 = 4-$(CH_3)_2NC_6H_4$, R_2 = 3-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.75 (d, 1H, *J* = 2.2 Hz, H_2-quinoline), 8.07 (d, 1H, *J* = 8.4 Hz, H_8-quinoline), 7.92 (br d, 1H, *J* = 1.8 Hz, H_4-quinoline), 7.64–7.70 (m, 3H, $(CH_3)_2NC_6H_4CO_2$, H_5-quinoline), 7.49 (br dm, 1H, *J* = 8.0 Hz, H_7-quinoline), 7.48 (m, 1H, H_6-quinoline), 7.24–7.32 (m, 5H, Ph), 7.03 (t, 1H, *J* = 1.4 Hz, C*H*=C), 6.46 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.69 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 4.54 (AB q, 2H, *J* = 12.0 Hz, $PhCH_2OCH_2$), 4.41 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 3.74–3.76 (m, 3H, $C_6H_5CH_2OCH_2$, C*H*H-lactone), 3.64 (AB d, 1H, *J* = 10.1 Hz, CH*H*-lactone), 2.99 (s, 6H, $N(CH_3)_2$);^{13}C NMR (100 MHz, $CDCl_3$): δ 172.00, 166.14, 153.56, 151.23, 148.43, 137.18, 135.74, 134.90, 131.40, 129.93, 129.41, 129.00, 128.98, 128.62, 128.09, 128.06, 127.80, 127.77, 126.93, 115.51, 110.74, 87.48, 74.00, 70.75, 63.01, 40.09, 29.32; IR (neat): 1762 (CO), 1702 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 523.2 (MH^+, 100%). This material was used in the next step without further attempts to obtain an analytically pure sample.

11-*E* (R_1 = 4-$CH_3OC_6H_4$, R_2 = 2-p$^-$ yridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.69 (dm, 2H, *J* = 4.8 Hz, H_6-pyridine), 7.87 (m, 2H, $CH_3OC_6H_4CO_2$), 7.72 (td, 1H, *J* = 7.7, 1.8 Hz, H_4-pyridine), 7.51 (t, 1H, *J* = 3.0 Hz, C*H*=C), 7.40 (d, 1H, *J* = 7.7 Hz, H_3-pyridine), 7.21–7.30 (m, 6H, Ph, H_5-pyridine), 6.85 (m, 2H, $CH_3OC_6H_4CO_2$), 4.60 (AB m, 2H, CO_2CH_2), 4.51 (AB q, 2H, *J* = 11.9 Hz, $C_6H_5CH_2OCH_2$), 3.83 (s, 3H, $CH_3OC_6H_4$), 3.71 (AB q, 2H, *J* = 10.1 Hz, $C_6H_5CH_2OCH_2$), 3.54 (dd, H, *J* = 19.6, 3.0 Hz, C*H*H-lactone), 3.47 (dd, 1H, *J* = 19.6, 3.0 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.31, 165.79, 163.69, 153.84, 150.09, 137.54, 136.65, 133.79, 131.90, 129.77, 128.55, 127.94, 127.79, 126.97, 123.43, 121.89, 113.77, 83.64, 73.87, 72.10, 66.46, 55.55, 34.35; IR (neat): 1755 (CO), 1714 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 460.2 (MH^+, 95%), 135.1 (MH^+, 100%); Anal. ($C_{27}H_{25}NO_6$) C, H, N.

11-*Z* (R_1 = 4-$CH_3OC_6H_4$, R_2 = 2-pyridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.44 (d, *J* = 4.6 Hz, 1H, H_6-pyridine), 7.78 (m, 2H, $CH_3OC_6H_4CO_2$), 7.49 (td, 1H, *J* = 7.7, 1.8, Hz, H_4-pyridine), 7.24–7.31 (m, 5H, Ph), 7.17 (irregular br t, 1H, C*H*=C), 7.13 (d, 1H, *J* = 7.7 Hz, H_3-pyridine), 7.11 (br dd, 1 H, *J* ≈ 7.6, 5.1, H_5-pyridine), 6.85 (m, 2H, $CH_3OC_6H_4CO_2$), 4.63 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 4.56 (AB q, 2H, *J* = 12.0 Hz, $PhCH_2O$), 4.48 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 3.84 (s, 3H, $CH_3OC_6H_4$), 3.74–377 (m, 3H, $PhCH_2OCH_2$, C*H*H-lactone), 6.63 (AB d, 1H, *J* = 10 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.19, 165.52, 163.75, 156.05, 149.05, 148.82, 137.37, 137.24, 134.02, 131.86, 128.59, 128.05, 127.82, 123.60, 122.12, 121.71, 113.82, 87.05, 73.96, 70.78, 63.65,

55.58, 33.94; IR (neat): 1769 (CO), 1709 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 460.2 (MH^+, 100%); Anal. ($C_{27}H_{25}NO_6$•$0.5H_2O$) C, H, N.

11-*E* (R_1 = 4-$CH_3OC_6H_4$, R_2 = 3-pyridyl)—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.70 (d, 1H, *J* = 2.1 Hz, H_2-pyridine), 8.59 (dd, 1H, *J* = 4.8, 1.6 Hz, H_6-pyridine), 7.84 (m, 2H, $CH_3OC_6H_4CO_2$), 7.73 (br dt, 1H, *J* = 8.0 Hz, H_4-pyridine), 7.51 (t, 1H, *J* = 2.9 Hz, C*H*=C), 7.34 (br dd, 1H, *J* ≈ 8.0, 4.5 Hz, H_5-pyridine), 7.23–7.31 (m, 5H, Ph), 6.84 (m, 2H, $CH_3OC_6H_4CO_2$), 4.58 (AB q, *J* = 12.1 Hz, PhCH_2O), 4.53 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.46 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 3.82 (s, 3H, $CH_3OC_6H_4$), 3.69 (AB q, 2H, *J* = 10.0 Hz, PhCH_2O), 3.26 (dd, 1H, *J* = 17.8, 2.9 Hz, C*H*H-lactone), 3.12 (dd, 1H, *J* = 17.8, 2.9 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.40, 165.61, 163.78, 150.98, 150.36, 137.21, 136.35, 132.83, 131.82, 130.46, 128.58, 128.06, 127.80, 127.31, 123.81, 121.50, 113.81, 82.94, 73.86, 71.64, 66.18, 55.53, 33.08; IR (neat): 1757 (CO), 1715 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 135.1 (100%), 460.2 (MH^+, 96%); Anal. ($C_{27}H_{25}NO_6$) C, H, N.

11-*Z* (R_1 = 4-$CH_3OC_6H_4$, R_2 = 3-pyridyl)—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.45 (br s, 2H, H_2 and H_6-pyridine), 7.81 (m, 2H, $CH_3OC_6H_4CO_2$), 7.43 (br dt, 1H, *J* = 8.0 Hz, H_4-pyridine), 7.24–7.35 (m, 5H, Ph), 7.10 (br dd, 1H, *J* ≈ 7.8, 4.8 Hz, H_5-pyridine), 6.96 (br t, 1H, *J* ≈ 1.5 Hz, C*H*=C), 6.87 (m, 2H, $CH_3OC_6H_4CO_2$), 4.68 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 4.54 (AB q, 2H, *J* = 12.0 Hz, $C_6H_5CH_2O$), 4.45 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 3.86 (s, 3H, $CH_3OC_6H_4$), 3.75 (AB d, 1H, *J* = 10 Hz, $C_6H_5CH_2OCHH$), 3.61 (AB d, 1H, *J* = 10 Hz, $PhCH_2OCHH$-), 3.56 (AB m, 2H, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.79, 165.56, 163.89, 149.80, 148.13, 137.10, 136.61, 135.18, 132.92, 131.83, 128.67, 128.18, 127.87, 123.80, 121.50, 114.26, 113.95, 87.14, 74.01, 70.66, 63.49, 55.62, 29.16; IR (neat): 1763 (CO), 1716 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 460.2 (MH^+, 100%); Anal. ($C_{27}H_{25}NO_6$•$0.5H_2O$) C, H, N.

11-*E* (R_1 = 4-$CH_3OC_6H_4$, R_2 = 4-pyridyl)—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.69 (irregular d, 2H, *J* ≈ 6.0 Hz, H_2 and H_6-pyridine), 7.83 (m, 2H, $CH_3OC_6H_4CO_2$), 7.45 (br t, 1H, *J* = 3.0 Hz, C*H*=C), 7.34 (br d, 2H, *J* ≈ 6.0 Hz, H_3 and H_5-pyridine), 7.26–7.30 (m, 5H, Ph), 6.86 (m, 2H, $CH_3OC_6H_4CO_2$), 4.58 (AB q, 2H, *J* = 12.0 Hz, $C_6H_5CH_2O$), 4.55 (AB d, 1H, *J* = 12.0 Hz, CO_2CHH), 4.46 (AB d, 1H, *J* = 12.0 Hz, CO_2CHH), 3.81 (s, 3H, $CH_3OC_6H_4$), 3.74 (AB q, 2H, *J* = 10.1 Hz, $C_6H_5CH_2OCH_2$), 3.69 (AB d, 1H, *J* = 10.1 Hz, $C_6H_5CH_2OCHH$), 3.28 (dd, 1H, *J* = 18.1, 3.0 Hz, C*H*H-lactone), 3.15 (dd, 1H, *J* = 18.1, 3.0 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.04, 165.66, 163.91, 149.89, 149.87, 137.17, 133.11, 131.90, 128.67, 128.20, 127.90, 123.71, 121.46, 113.89, 83.34, 73.97, 71.61, 66.12, 55.61, 33.15, 31.71, 22.78; IR (neat): 1760 (CO), 1715 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 460.2 (MH^+, 100%); Anal. ($C_{27}H_{25}NO_6$) C, H, N.

11-*Z* (R_1 = 4-$CH_3OC_6H_4$, R_2 = 4-pyridyl)—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.35 (br d, 2H, *J* = 6.0 Hz, H_2 and H_6-pyridine), 7.82 (m, 2H, $CH_3OC_6H_4CO_2$), 7.26–7.34 (m, 5H, Ph), 7.07 (m, 2H, H_3 and H_5-pyridine), 7.05 (br t, 1H, *J* = 1.4 Hz, C*H*=C), 6.88 (m, 2H, $CH_3OC_6H_4CO_2$), 4.74 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.55 (AB q, *J* = 12.0 Hz, $C_6H_5CH_2O$), 4.45 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 3.88 (s, 3H, $CH_3OC_6H_4$), 3.79 (AB d, 1H, *J* = 10.0 Hz, $C_6H_5CH_2OCHH$), 3.65 (AB d, 1H, *J* = 10 Hz, $PhCH_2OCHH$), 3.58 (br s, 2H CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.71, 165.62, 164.04, 149.07, 148.85, 147.25, 137.06, 133.92, 131.86, 128.73, 128.31, 127.95, 124.32, 121.39, 114.02, 87.36, 74.13, 70.71, 63.43, 55.70, 31.27; IR (neat): 1761 (CO), 1702 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 460.3 (MH^+, 100%); Anal. ($C_{27}H_{25}NO_6$) C, H, N.

11-*E* (R_1 = 4-$CH_3OC_6H_4$, R_2 = 2-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.17 (d, 1H, *J* = 8.4 Hz, H_4-quinoline), 8.17 (d, 1H, *J* = 8.4 Hz, H_5-quinoline), 7.87 (m, 2H, $CH_3OC_6H_4CO_2$), 7.80 (br d, 1H, *J* = 8.4 Hz, H_8-quinoline), 7.73 (m, 1H, H_6-quinoline), 7.68 (t, 1H, *J* = 3.0 Hz, C*H*=C), 7.56 (m, 1H, H_7-quinoline), 7.49 (d, 1H, *J* = 8.4 Hz, H_3-quinoline), 7.24–7.32 (m, 5H, Ph), 6.84 (m, 2H, $CH_3OC_6H_4CO_2$), 4.62 (s, 2H, $C_6H_5CH_2OCH_2$), 4.55 (AB q, 2H, *J* = 11.9 Hz, CO_2CH_2), 3.81 (s, 3H, $CH_3OC_6H_4$), 3.71–3.79 (m, 3H, $C_6H_5CH_2OCH_2$, C*H*H-lactone), 3.66 (dd, 1H, *J* = 19.8, 3.0 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.18, 165.78, 163.64, 153.78, 148.41, 137.51, 136.57, 133.79, 131.86, 131.22, 130.07, 130.03, 128.54, 127.92, 127.78, 127.63, 127.51, 127.32, 123.89, 121.84, 113.75, 83.78, 73.84, 72.05, 66.47, 55.51, 34.63; IR (neat): 1761 (CO), 1715 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 510.3 (MH^+, 81%), 135.1 (MH^+, 100%); Anal. ($C_{31}H_{27}NO_6$•0.1H_2O) C, H, N.

11-*Z* (R_1 = 4-$CH_3OC_6H_4$, R_2 = 2-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.00 (br d, 1H, *J* = 8.5 Hz, H_4-quinoline), 7.95 (d, 1H, *J* = 8.3 Hz, H_5-quinoline), 7.73–7.77 (m, 3H, $CH_3OC_6H_4CO_2$, H_8-quinoline), 7.68 (m, 1H, Hz, H_7-quinoline), 7.51 (m, 1H, H_6-quinoline), 7.24–7.29 (m, 7H, Ph, H_3-quinoline, C*H*=C), 6.74 (m, 2H, $CH_3OC_6H_4CO_2$), 4.66 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 4.55 (AB q, 2H, *J* = 12.0 Hz, $C_6H_5CH_2O$), 4.53 (AB d, 1H, *J* = 11.8 Hz, C_6H_5CHHO), 4.50 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 3.98 (br AB d, 2H, *J* = 1.4 Hz, $C_6H_5CH_2OCH_2$), 3.81 (s, 3H, $CH_3OC_6H_4$), 3.78 (AB d, 1H, *J* = 10.0 Hz, C*H*H-lactone), 3.64 (AB d, 1H, *J* = 10.0 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.27, 165.47, 163.65, 157.39, 148.99, 137.19, 133.99, 131.72, 129.85, 128.84, 128.56, 128.03, 127.79, 127.64, 127.01, 126.47, 121.56, 121.43, 113.71, 87.14, 73.94, 70.80, 63.57, 55.52, 34.82; IR (neat): 1762 (CO), 1715 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 510.1 (MH^+, 100%); Anal. ($C_{31}H_{27}NO_5$) C, H, N.

11-*E* (R_1 = 4-$CH_3OC_6H_4$, R_2 = 3-quinolyl)—This intermediate was used directly in the next step without further purification or characterization.

11-*Z* (R_1 = 4-$CH_3OC_6H_4$, R_2 = 3-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.75 (d, 1H, *J* = 2.0 Hz, H_2-quinoline), 8.07 (d, 1H, *J* = 8.4 Hz, H_8-quinoline), 7.93 (d, 1H, *J* = 2.0 Hz, H_4-quinoline), 7.74 (m, 2H, $CH_3OC_6H_4CO_2$), 7.66 (m, 1H, H_7-quinoline), 7.62 (br dd, 1H, *J* ≈ 8.0, 1.5 Hz, H_5-quinoline), 7.51 (m, 1H, H_6-quinoline), 7.24–7.32 (m, 5H, Ph), 7.04 (t, 1H, *J* = 1.4 Hz, C*H*=C), 6.72 (m, 2H, $CH_3OC_6H_4CO_2$), 4.68 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 4.57 (AB q, 2H, *J* = 12.0 Hz, $C_6H_5CH_2O$), 4.45 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 3.79 (s, 3H, OCH_3), 3.71–3.74 (m, 3H, $C_6H_5CH_2OCH_2$, C*H*H-lactone), 3.62 (AB d, 1H, *J* = 10.0 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.85, 165.54, 163.72, 151.19, 148.19, 146.95, 137.07, 135.63, 135.12, 131.65, 129.87, 129.47, 129.06, 128.64, 128.15, 128.00, 127.83, 127.70, 127.01, 121.33, 113.80, 87.14, 74.00, 70.69, 63.45, 55.51, 29.32; IR (neat): 1763 (CO), 1714 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 510.2 (MH^+, 100%); Anal. ($C_{31}H_{27}NO_6$•0.5H_2O) C, H, N.

11-*E* (R_1 = $CH(CH_2CH_2CH_3)_2$, R_2 = 2-pyridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.69 (dm, 1H, *J* = 4.7 Hz, H_6-pyridine), 7.72 (td, 1H, *J* = 7.7, 1.8 Hz, H_4-pyridine), 7.48 (t, 1H, *J* = 3.0 Hz,C=C*H*), 7.42 (d, 1H, *J* = 7.7 Hz, H_3-pyridine), 7.21–7.34 (m, 6H, Ph, H_5-pyridine), 4.58 (s, 2H, $PhCH_2OCH_2$), 4.30 (s, 2H, CO_2CH_2), 3.65 (AB q, 2H, *J* = 10.1 Hz, $PhCH_2OCH_2$), 3.41 (m, 2H, CH_2-lactone), 2.29–3.36 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.46–1.52 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.29–1.35 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.11–1.23 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.74 and 0.78 (t, 6H, *J* = 7.3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); $CDCl_3$): δ ^{13}C NMR (100 MHz, 176.02, 171.24, 153.95, 150.09, 137.55, 136.63, 133.57, 129.88, 128.58, 127.98 127.78, 127.01, 123.37, 83.44, 73.91, 72.30, 65.98, 45.37, 34.95, 34.57, 34.30, 20.69, 14.02, 13.98; IR (neat):

1733 (CO), 1756 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 452.3 (MH^+, 93 %), 91.1 (100 %); Anal. ($C_{27}H_{33}NO_5$) C, H, N.

11-*E* (R_1 = $CH_2CH[CH_2CH(CH_3)_2]_2$, R_2 = 2-pyridyl)—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.69 (dm, 1H, *J* = 4.8 Hz, H_6-pyridine), 7.72 (td, 1H, *J* = 7.7, 1.8, Hz, H_4-pyridine), 7.47 (t, 1H, *J* = 3.0 Hz, C=C*H*), 7.41 (dm, 1H, *J* = 7.7 Hz, H_3-pyridine), 7.21–7.34 (m, 6H, Ph, H_5-pyridine), 4.54 (s, 2H, $C_6H_5CH_2OCH_2$), 4.25 (s, 2H, CO_2CH_2), 3.59 (AB q, 2H, *J* = 10.0 Hz, $C_6H_5CH_2OCH_2$), 3.46 (dd, 1H, *J* = 19.7, 3.0 Hz, C*H*H-lactone), 3.33 (dd, 1H, *J* = 19.7, 3.0 Hz, CH*H*-lactone), 2.18 (d, 2H, *J* = 6.5 Hz, $CH_2CH[CH_2CH(CH_3)_2]_2$), 1.84–1.91 (m, 1H, $CH_2CH[CH_2CH(CH_3)_2]_2$), 1.51–1.57 (m, 2H, $CH_2CH[CH_2CH(CH_3)_2]_2$), 0.99–1.12 (m, 4H, $CH_2CH[CH_2CH(CH_3)_2]_2$), 0.77–0.82 (m, 12H, $CH_2CH[CH_2CH(CH_3)_2]_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 186.59, 173.03, 171.17, 153.92, 150.09, 137.56, 136.62, 133.71, 129.74, 128.55 127.94, 127.75, 127.01, 123.37, 83.28, 73.85, 72.20, 65.98, 44.11, 39.46, 34.23, 30.68, 25.20, 22.65, 22.92, 22.67, 22.63; IR (neat): 1758 (CO), 1741 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 494.2 (MH^+, 88%), 91.1 (100%); Anal. ($C_{30}H_{39}NO_5$) C, H, N.

11-*Z* (R_1 = $CH(CH_2CH_2CH_3)_2$, R_2 = 2-pyridyl)—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.53 (dm, 1H, *J* = 4.9 Hz, H_6-pyridine), 7.60 (td, 1H, *J* = 7.7, 1.8 Hz, H_4-pyridine), 7.23–7.34 (m, 6H, Ph, H_3-pyridine), 7.17 (m, 1H, H_5-pyridine), 7.12 (t, 1H, *J* = 1.4 Hz, C=C*H*), 4.53 (AB q, 2H, *J* = 12.0 Hz, CO_2CH_2), 4.33 (s, 2H, $C_6H_5CH_2OCH_2$), 3.81 (s, 2H, $C_6H_5CH_2OCH_2$), 3.70 (AB d, 1H, *J* = 10.0 Hz, C*H*-lactone), 3.57 (AB d, 1H, *J* = 10.0 Hz, C*H*-lactone), 2.26–3.33 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.44–1.54 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.30–1.39 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.17–1.26 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.83–0.87 (2 t, 6H, *J* = 7.2 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.77, 172.14, 148.73, 137.29, 128.61, 128.07, 127.78, 123.71, 123.70, 123.67, 122.17, 86.63, 73.99, 70.89, 63.31, 45.18, 34.50, 34.46, 20.68, 20.65, 14.11, 14.09; IR (neat): 1764 (CO), 1765 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 452.2 (MH^+, 100%); Anal. ($C_{27}H_{33}NO_5$•$0.6H_2O$) C, H, N.

11-*E* (R_1 = $CH(CH_2CH_2CH_3)_2$, R_2 = 3-pyridyl)—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.74 (s, 1H, H_2-pyridine), 8.61 (br d, 1H, *J* = 4.0 Hz, H_6-pyridine), 7.75 (dm, 1H, *J* = 8.0 Hz, H_4-pyridine), 7.75 (t, 1H, *J* = 2.9 Hz, C=C*H*), 7.37 (dd, 1H, *J* = 8.0, 4.8 Hz, H_5-pyridine), 7.25–7.33 (m, 5H, Ph), 4.56 (s, 2H, $C_6H_5CH_2O$), 4.28 (AB q, 2H, *J* = 11.9 Hz, $CH_2CO_2CH_2$), 3.61 (AB q, 2H, *J* = 10 Hz, $C_6H_5CH_2OCH_2$), 3.20 (dd, 1H, *J* = 17.9, 2.9 Hz, C*H*H-lactone), 3.02 (dd, 1H, *J* = 17.9, 2.9 Hz, CH*H*-lactone), 2.29–3.36 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.43–1.52 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.29–1.38 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.10–1.24 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.73–0.80 (overlapping t, 6H, *J* = 7.3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.85, 170.30, 151.08, 150.45, 137.19, 136.37, 132.76, 130.52, 128.61, 128.12, 127.81, 127.26, 123.83, 82.61, 73.90, 71.79, 65.72, 45.25, 34.52, 34.48, 33.02, 20.69, 20.64, 13.98, 13.94; IR (neat): 1757 (CO), 1734 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 452.3 (MH^+, 91%), 91.1 (100%); Anal. ($C_{27}H_{33}NO_5$) C, H, N.

11-*Z* (R_1 = $CH(CH_2CH_2CH_3)_2$, R_2 = 3-pyridyl)—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.52 (s, 2H, H_2 and H_6-pyridine), 7.60 (dm, 1H, *J* = 7.8 Hz, H_5-pyridine), 7.23–7.34 (m, 6H, Ph, H_4-pyridine), 6.92 (t, 1H, *J* = 1.5 Hz, C=C*H*), 4.51 (AB q, 2H, *J* = 11.9 Hz, CO_2CH_2), 4.32 (s, 2H, $C_6H_5CH_2OCH_2$), 3.68 (AB d, 1H, *J* = 10.0 Hz, C*H*H-lactone), 3.62 (br s, 2H, $C_6H_5CH_2OCH_2$), 3.53 (AB d, 1H, *J* = 10.0 Hz, CH*H*-lactone), 2.26–3.33 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.44–1.54 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.30–1.39 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.17–1.26 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.83–0.87 (overlapping t, 6H, *J* = 7.3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.76, 171.63, 149.43, 148.33, 147.78, 137.18, 137.09, 135.00, 128.66, 128.19, 127.83,

86.62, 74.02, 70.71, 63.20, 45.16, 34.50, 34.48, 29.18, 20.70, 20.65, 14.09, 14.07; IR (neat): 1768 (CO), 1734 (CO) cm^{-1}; 452.3 (MH^+, 100%); FAB-MS (m/z, relative intensity); Anal. ($C_{27}H_{33}NO_5$) C, H, N.

11-*E* (R_1 = CH($CH_2CH_2CH_3$)$_2$, R_2 = 4-pyridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.71 (d, 2H, *J* = 6.1 Hz, H_2 and H_6-pyridine), 7.46 (t, 1H, *J* = 2.9 Hz, C*H*=C), 7.35 (br d, 2H, *J* = 6.1 Hz, H_3 and H_5-pyridine), 7.24–7.34 (m, 4H, Ph), 4.56 (s, 2H, $C_6H_5CH_2OCH_2$), 4.29 (s, 2H, CO_2CH_2), 3.62 (AB q, 2H, *J* = 10.1 Hz, $C_6H_5CH_2OCH_2$), 3.22 (dd, 1H, *J* = 18.2, 2.9 Hz, C*H*H-lactone), 3.05 (dd, 1H, *J* = 18.2, 2.9 Hz, CH*H*-lactone), 2.30–3.33 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.46–1.52 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.32–1.37 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.15–1.25 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.75–0.82 (overlapping t, 6H, *J* = 7.3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 174.87, 168.87, 148.75, 136.13, 131.92, 127.68, 127.24, 126.89, 122.81, 81.97, 72.99, 70.73, 64.65, 52.56, 44.29, 33.57, 33.52, 32.08, 19.74, 19.69, 13.03, 12.99; IR (neat): 1765 (CO), 1735 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 452.3 (MH^+, 100%); Anal. ($C_{27}H_{33}NO_5 \cdot H_2O$) C, H, N.

11-*Z* (R_1 = CH($CH_2CH_2CH_3$)$_2$, R_2 = 4-pyridyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.48 (d, 2H, *J* = 6.0 Hz, H_2 and H_6-pyridine), 7.23–7.36 (m, 5H, Ph), 7.16 (d, 2H, *J* = 6.0 Hz, H_3 and H_5-pyridine), 6.97 (t, 1H, *J* = 1.4 Hz, C*H*=C), 4.51 (AB q, 2H, *J* = 11.8 Hz, CO_2CH_2), 4.33 (s, 2H, $C_6H_5CH_2OCH_2$), 3.72 (AB d, 1H, *J* = 10.0 Hz, C*H*H-lactone), 3.62 (s, 2H, $C_6H_5CH_2OCH_2$), 3.57 (AB d, 1H, *J* = 10.0 Hz, CH*H*-lactone), 2.27–3.34 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.45–1.54 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.32–1.41(m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.16–1.27 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.84–0.88 (overlapping t, 6H, *J* = 7.3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.80, 171.61, 149.62, 148.77, 137.06, 134.10, 128.72, 128.32, 127.90, 124.29, 86.72, 74.12, 70.70, 63.23, 45.22, 34.54, 34.50, 31.27, 20.74, 20.68, 14.12, 14.10; IR (neat): IR (neat): 1764 (CO), 1718 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 452.3 (MH^+, 100%); Anal. ($C_{27}H_{33}NO_5 \cdot 0.6H_2O$) C, H, N.

11-*E* (R_1 = CH($CH_2CH_2CH_3$)$_2$, R_2 = 2-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.18 (d, 1H, *J* = 8.4 Hz, H_4-quinoline), 8.09 (d, 1H, *J* = 8.4 Hz, H_5-quinoline), 7.81 (d, 1H, *J* = 8.4 Hz, H_8-quinoline), 7.73 (m, 1H, H_6-quinoline), 7.65 (t, 1H, *J* = 3.0, Hz, C*H*=C), 7.57 (m, 1H, H_7-quinoline), 7.51 (d, 1H, *J* = 8.4 Hz, H_3-quinoline), 7.24–7.31 (m, 5H, Ph), 4.60 (s, 2H, $PhCH_2OCH_2$), 4.35 (s, 2H, CO_2CH_2), 3.67 (AB q, 2H, *J* = 10.0 Hz, $PhCH_2OCH_2$), 3.54–3.61 (m, 2H, CH_2-lactone), 2.30–3.37 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.45–1.55 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.28–1.36 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.11–1.23 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.68 and 0.76 (t, 6H, *J* = 7.3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.05, 171.13, 153.88, 148.48, 137.55, 136.59, 133.60, 131.36, 130.09, 130.05, 128.59, 127.98, 127.80, 127.67, 127.54, 127.33, 124.00, 83.61, 73.91, 72.29, 65.96, 45.36, 34.60, 34.56, 20.69, 14.00, 13.94; IR (neat): 1763 (CO), 1735 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 502.3 (MH^+, 100%); Anal. ($C_{31}H_{35}NO_5 \cdot 0.5H_2O$) C, H, N.

11-*Z* (R_1 = CH($CH_2CH_2CH_3$)$_2$, R_2 = 2-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.03–8.07 (irregular t, 2H, *J* ≈ 9 Hz, H_4 and H_5-quinoline), 7.79 (dm, 1H, *J* = 8.2 Hz, H_8-quinoline), 7.70 (m, 1H, H_6-quinoline), 7.52 (m, 1H, H_7-quinoline), 7.36 (d, 1H, *J* = 8.4 Hz, H_3-quinoline), 7.20–7.23 (m, 5H, Ph), 7.17 (br t, 1H, *J* = 1.4 Hz, C*H*=C), 4.50 (AB q, 2H, *J* = 12.0 Hz, CO_2CH_2), 4.33 (s, 2H, $C_6H_5CH_2OCH_2$), 4.00 (s, 2H, $C_6H_5CH_2OCH_2$), 3.69 (AB d, 1H, *J* = 10.0 Hz, C*H*H-lactone), 3.56 (AB d, 1H, *J* = 10.0 Hz, CH*H*-lactone), 2.22–3.29 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.40–1.50 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.24–1.34 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.13–1.22 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$),

0.81 (t, 6H, *J* = 7.2 Hz, ($CH_3CH_2CH_2$)$_2$CHCO$_2$CH$_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.68, 172.16, 157.46, 148.92, 137.20, 137.16, 133.99, 129.87, 128.88, 128.86, 128.53, 128.00, 127.71, 127.66, 127.06, 126.50, 121.54, 121.52, 86.65, 73.91, 70.82, 63.26, 45.11, 34.80, 34.65, 34.42, 34.39, 20.60, 20.57, 14.02, 14.00; IR (neat): 1766 (CO), 1735 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 502.2 (MH^+, 82%), 91.1 (MH^+, 100%); Anal. ($C_{31}H_{35}NO_5$•0.2H_2O) C, H, N.

11-*E* (R_1 = CH($CH_2CH_2CH_3$)$_2$, R_2 = 3-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.03 (d, 1H, *J* = 2.1 Hz, H_2-quinoline), 8.22 (d, 1H, *J* = 1.8 Hz, H_4-quinoline), 8.13 (d, 1H, *J* = 8.4 Hz, H_5-quinoline), 7.87 (d, 1H, *J* = 8.4 Hz, H_8-quinoline), 7.79 (m, 1H, H_7-quinoline), 7.70 (t, 1H, *J* = 2.9 Hz, C*H*=C), 7.62 (m, 1H, H_6-quinoline), 7.26–7.33 (m, 5H, Ph), 4.58 (s, 2H, $C_6H_5CH_2OCH_2$), 4.33 (AB q, 2H, *J* = 12.0 Hz, CO_2CH_2), 3.60 (AB q, 2H, *J* = 10.0 Hz, $C_6H_5CH_2OCH_2$), 3.32 (dd, 1H, *J* = 17.9, 2.9 Hz, C*H*H-lactone), 3.14 (dd, 1H, *J* = 17.9, 2.9 Hz, CH*H*-lactone), 2.32–3.36 (m, 1H, ($CH_3CH_2CH_2$)$_2$C*H*CO$_2$CH$_2$-), 1.39–1.52 (m, 2H, ($CH_3CH_2CH_2$)$_2$CHCO$_2$CH$_2$), 1.31–1.39 (m, 2H, ($CH_3CH_2CH_2$)$_2$CHCO$_2$CH$_2$), 1.10–1.25 (m, 4H, ($CH_3CH_2CH_2$)$_2$CHCO$_2$CH$_2$), 0.73 and 0.78 (t, 6H, *J* = 7.3 Hz, ($CH_3CH_2CH_2$)$_2$CHCO$_2$CH$_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.94, 170.45, 151.05, 148.02, 137.22, 136.86, 132.98, 131.16, 129.50, 128.66, 128.50, 128.17, 127.89, 127.86, 127.77, 127.65, 127.15, 82.69, 73.99, 71.86, 65.78, 45.29, 34.57, 34.52, 33.21, 20.74, 20.69, 14.02, 13.97; IR (neat): 1752 (CO), 1735 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 502.5 (MH^+, 100%). This material was used in the next step without further attempts to obtain an analytically pure sample.

11-*Z* (R_1 = CH($CH_2CH_2CH_3$)$_2$, R_2 = 3-quinolyl)—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.77 (d, 1H, *J* = 2.2 Hz, H_2-quinoline), 8.07 (d, 1H, *J* = 8.4 Hz, H_5-quinoline), 7.98 (d, 1H, *J* = 1.9 Hz, H_4-quinoline), 7.64–7.70 (m, 2H, H_7 and H_8-quinoline), 7.50 (m, 1H, *J* = 1.2, 8.1, 8.4 Hz, H_6-quinoline), 7.18–7.29 (m, 5H, Ph), 6.94 (t, 1H, *J* = 1.5 Hz, C*H*=C), 4.47 (AB q, 2H, *J* = 12.0 Hz, $C_6H_5CH_2OCH_2$), 4.30 (AB q, 2H, *J* = 11.8 Hz, CO_2CH_2), 3.80 (br s, 2H, $C_6H_5CH_2OCH_2$), 3.65 (AB d, 1H, *J* = 10.0 Hz, C*H*H-lactone), 3.52 (AB d, 1H, *J* = 10.0 Hz, CH*H*-lactone), 2.20–3.27 (m, 1H, ($CH_3CH_2CH_2$)$_2$C*H*CO$_2$CH$_2$), 1.37–1.47 (m, 2H, ($CH_3CH_2CH_2$)$_2$CHCO$_2$CH$_2$), 1.23–1.31 (m, 2H, ($CH_3CH_2CH_2$)$_2$CHCO$_2$CH$_2$), 1.10–1.20 (m, 4H, ($CH_3CH_2CH_2$)$_2$CHCO$_2$CH$_2$), 0.78 and 0.81 (t, 6H, *J* = 7.2 Hz, ($CH_3CH_2CH_2$)$_2$CHCO$_2$CH$_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.50, 171.55, 151.25, 148.10, 147.09, 136.96, 135.34, 135.07, 129.81, 129.31, 129.11, 128.45, 127.96, 127.91, 127.58, 127.50, 126.93, 86.47, 73.79, 70.55, 63.02, 44.97, 34.28, 34.26, 29.20, 20.49, 20.20, 13.93, 13.88; IR (neat): 1764 (CO), 1735 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 91.1 (MH^+, 100%), 502.2 (MH^+, 82%); Anal. ($C_{31}H_{35}NO_5$•0.2H_2O) C, H, N.

General Procedure for the Synthesis of 12 (R_2 ≠ 1-methylindole)

BCl_3 (3 equiv) was added slowly to a stirring solution of **11** (1 equiv) in CH_2Cl_2 (20 mL/mmol of **11**) at −78 °C. The reaction was monitored by TLC and quenched upon completion by the slow addition of a saturated aqueous $NaHCO_3$ solution, diluted with CH_2Cl_2 (20 mL/mmol of **11**), and warmed to room temperature. The layers were separated, and the aqueous layer was further extracted with CH_2Cl_2 (2 ×). The combined organics were dried ($MgSO_4$) and concentrated in vacuo. Purification by silica gel flash column chromatography [CH_2Cl_2-MeOH (0% → 10%)] gave **12**.

12a-*E*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$/CD_3OD): δ 8.67 (br d, 1H, *J* = 3.8 Hz, H_6-pyridine), 7.80 (d, 2H, *J* = 9.0 Hz, (CH_3)$_2$NC$_6H_4$CO$_2$), 7.72 (br t, 1H, *J* = 7.3, 7.6 Hz, H_4-pyridine), 7.50 (irregular t, 1H, *J* ≈ 2.9 Hz, C*H*=C), 7.41 (d, 1H, *J* = 7.6 Hz, H_3-pyridine), 7.22 (m, 1H, H_5-pyridine), 6.57 (d, 2H, *J* = 9.0 Hz, (CH_3)$_2$NC$_6H_4$CO$_2$), 4.51 (AB d, 1H, *J* = 12.0 Hz, CO$_2$C*H*H), 4.39 (AB d, 1H, *J* = 12.0 Hz, CO$_2$CH*H*), 3.82 (AB d, 1H, *J* = 12.3 Hz,

HOC*H*H), 3.75 (AB d, 1H, *J* = 12.3 Hz,, HOC*H*H), 3.52 (dd, 1H, *J* = 19.8, 2.9 Hz, C*H*H-lactone), 3.40 (dd, 1H, *J* = 19.8, 2.9 Hz, CH*H*-lactone), 3.00 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3/CD_3OD$): δ 171.76, 166.88, 153.70, 153.68, 150.03, 136.77, 134.11, 131.67, 129.90, 126.95, 123.55, 115.75, 110.83, 85.06, 65.56, 64.83, 40.13, 33.54; IR (neat): 3370 (OH), 1719 (CO), 1626 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 383.1 (MH^+, 84%), 148.1 (100%); HRMS (FAB) calc for $C_{21}H_{22}N_2O_5$, 383.1607; found, 383.1640.

12b-*E*—white solid, m.p: 158–159°C; ^{1}H NMR (400 MHz, $CDCl_3/CD_3OD$): δ 8.63 (s, 1H, H_2-pyridine), 8.50 (d, 1H, *J* = 4.2 Hz, H_6-pyridine), 7.78 (d, 1H, *J* = 8.0 Hz, H_4-pyridine), 7.69 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 7.45 (t, 1H, *J* = 2.8 Hz, C*H*=C), 7.35 (dd, 1H, *J* = 8.0, 4.8 Hz, H_5-pyridine), 6.52 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.39 (AB q, 2H, *J* = 12.0 Hz, CO_2CH_2), 3.80 (AB d, 1H, *J* = 12.2 Hz, HOC*H*H), 3.70 (AB d, 1H, *J* = 12.2 Hz, HOCH*H*), 3.27 (dd, 1H, *J* = 17.8, 2.8 Hz, C*H*H-lactone), 3.08 (dd, 1H, *J* = 17.8, 2.8 Hz, C*H*H-lactone), 2.97 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3/CD_3OD$): δ 171.19, 166.70, 153.73, 150.66, 149.88, 136.75, 132.63, 131.53, 130.75, 128.06, 124.04, 115.27, 110.74, 84.78, 65.48, 64.31, 40.02, 32.20; IR (neat): 3402 (OH), 1702 (CO), 1654 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 383.2 (MH^+, 57%), 148.1 (100%); Anal. ($C_{21}H_{22}N_2O_5$•0.1H_2O) C, H, N.

12b-*Z*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.19 (m, 1H, H_2-pyridine), 9.10 (m, 1H, H_6-pyridine), 8.00 (br d, 1H, *J* = 8.0 Hz, H_4-pyridine), 7.74 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 7.46 (dd, 1H, *J* = 8.0, 6.1 Hz, H_5-pyridine), 7.05 (t, 1H, *J* = 1.2 Hz, C*H*=C), 6.62 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.72 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.46 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 3.88 (s, 2H, $HOCH_2$), 3.79 (AB q, 2H, *J* = 16.0 Hz, CH_2-lactone), 3.07 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.61, 166.50, 150.00, 144.63, 144.05, 143.19, 132.65, 131.68, 125.91, 125.89, 111.30, 111.28, 89.28, 63.48, 62.43, 40.41, 29.17; IR (neat): 3412 (OH), 1715 (CO), 1637 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 383.1 (MH^+, 60%), 148.1 (100%); HRMS (FAB) calc for $C_{21}H_{22}N_2O_5$, 383.1607; found, 383.1590.

12c-*E*—yellow solid, m.p: 130–133°C; ^{1}H NMR (400 MHz, DMSO- 8.75 (d, *J* = 6.2 d_6): δ Hz, 2H, H_2 and H_6-pyridine), 7.72 (d, 2H, *J* = 6.2 Hz, H_3 and H_5-pyridine), 7.63 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 7.46 (t, 1H, *J* = 2.9 Hz, C*H*=C), 6.67 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.40 (AB q, 2H, *J* = 11.9 Hz, CO_2CH_2), 3.69 (AB q, 2H, *J* = 11.9 Hz, $HOCH_2$), 3.32 (dd, 1H, *J* = 18.7, 2.9, Hz, C*H*H-lactone), 3.26 (dd, 1H, *J* = 18.7, 2.9 Hz, CH*H*-lactone), 2.99 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, DMSO-d_6): δ 170.00, 165.29, 153.38, 148.38, 133.31, 130.80, 130.73, 124.36, 124.35, 124.33, 124.32, 114.89, 110.82, 110.78, 84.95, 65.56, 63.20, 32.01; IR (neat): 3176 (OH), 1750 (CO), 1713 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 383.2 (MH^+, 100%); Anal. ($C_{21}H_{22}N_2O_5$•0.9H_2O) C, H, N.

12c-*Z*—white solid, m.p: 142–143°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.39 (v br d, *J* = 4.7 Hz, 2H, H_2 and H_6-pyridine), 7.78 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 7.19 (br d, 2H, *J* = 5.6 Hz, H_3 and H_5-pyridine), 7.09 (br s, 1H, C*H*=C), 6.61 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.67 (AB d, 1H, *J* = 12.0 Hz, CO_2CHH), 4.48 (AB d, 1H, *J* = 12.0 Hz, CO_2CHH), 3.81–3.88 (AB m, 2H, $HOCH_2$), 3.63 (s, 2H, CH_2-lactone), 3.08 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.81, 166.52, 153.97, 150.24, 144.76, 132.75, 131.68, 129.34, 126.04, 118.84, 114.93, 110.87, 89.37, 63.43, 62.48, 43.21, 40.26, 31.70; IR (neat): 3175 (OH), 1755 (CO), 1715.41 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 383.1 (MH^+, 40%), 176 (MH^+, 100%); Anal. ($C_{21}H_{22}N_2O_5$•0.4H_2O) C, H, N.

12d-*E*—yellow solid, m.p: 120–122°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.17 (d, 1H, *J* = 8.4 Hz, H_4-quinoline), 8.05 (d, 1H, *J* = 8.4 Hz, H_5-quinoline), 7.66 (dm, 1H, *J* = 8.4 Hz, H_8-quinoline), 7.65–7.69 (m, 3H, $(CH_3)_2NC_6H_4CO_2$, H_7-quinoline), 7.61 (t, 1H, *J* = 3.0 Hz, C*H*=C), 7.48–7.53 (m, 2H, H_3, and H_6-quinoline), 6.49 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.40 (AB

q, 2H, *J* = 12.00 Hz, CO_2CH_2), 3.80 (AB d, 1H, *J* = 12.2 Hz, HOC*H*H), 3.72 (AB d, 1H, *J* = 12.2 Hz, HOCH*H*), 3.61 (dd, 1H, *J* = 19.6, 3.0 Hz, C*H*H-lactone), 3.50 (dd, 1H, *J* = 19.6, 3.0 Hz, CH*H*-lactone), 2.92 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.10, 167.40, 154.21, 153.39, 139.00, 132.79, 132.76, 131.85, 131.58, 128.60, 128.37, 128.12, 123.43, 115.87, 111.26, 110.62, 86.14, 66.25, 64.75, 43.29, 40.17, 33.88; IR (neat): 3378 (OH), 1752 (CO), 1698 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 433.3 (MH^+, 61%), 148.1 (MH^+, 100%); Anal. ($C_{25}H_{24}N_2O_5$•$0.1H_2O$) C, H, N.

12d-*Z*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.96 (v br d, 2H, *J* = 8.4 Hz, and H_4 H_5-quinoline), 7.66–7.70 (m, 3H, $(CH_3)_2NC_6H_4CO_2$, H_8-quinoline), 7.60 (m, 1H, H_7-quinoline), 7.42 (m, 1H, H_6-quinoline), 7.23 (d, 1H, *J* = 8.4 Hz, H_3-quinoline), 7.15 (br s, 1H, C*H*=C), 6.44 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.45 (s, 2H, CO_2CH_2), 3.92 (AB d, 2H, *J* = 1.3 Hz, $HOCH_2$), 3.75 (AB q, 2H, *J* = 12.0 Hz, CH_2-lactone), 2.93 (s, 6H, $N(CH_3)_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.41, 166.67, 157.21, 153.75, 149.38, 137.85, 133.88, 131.69, 130.27, 128.39, 127.71, 127.16, 126.76, 121.75, 115.48, 110.79, 110.17, 88.63, 63.52, 62.99, 40.16, 34.56; IR (neat): 3392 (OH), 1760 (CO), 1703 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 433.2 (MH^+, 100%); Anal. ($C_{25}H_{24}N_2O_5$•$0.1H_2O$) C, H, N.

12e-*E*—white solid, m.p: 135–137°C; ^{1}H NMR (400 MHz, DMSO- 9.12 (d, 1H, *J* = d_6): δ 2.2 Hz, H_2-quinoline), 8.65 (br d, 1H, *J* = 1.7 Hz, H_4-quinoline), 8.10 (dm, 1H, *J* = 8.4 Hz, H_5-quinoline), 8.04 (d, 1H, *J* = 8.4 Hz, H_8-quinoline), 7.82 (m, 1H, H_7-quinoline), 7.62–7.69 (m, 4H, H_6-quinoline, $(CH_3)_2NC_6H_4CO_2$, C*H*=C), 6.65 (m, $(CH_3)_2NC_6H_4CO_2$), 4.41 (AB q, 2H, *J* = 11.9 Hz, CO_2CH_2), 3.71 (AB q, 2H, *J* = 11.9 Hz,, $HOCH_2$), 3.37–3.39 (m, 2H, CH_2-lactone), 2.97 (s, 6H, $(CH_3)_2NC_6H_4$); ^{13}C NMR (100 MHz, DMSO-d_6): δ 170.48, 165.35, 153.35, 151.67, 147.18, 136.28, 130.80, 130.77, 129.27, 128.81, 128.71, 127.82, 127.37, 127.23, 114.95, 110.77, 84.62, 65.76, 63.36, 32.04; IR (neat): 3424 (OH), 1749 (CO), 1677 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 433.2 (MH^+, 89%), 148.1 (MH^+, 100%); Anal. ($C_{25}H_{24}N_2O_5$•$0.8H_2O$) C, H, N.

12e-*Z*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$/CD_3OD): δ 8.68 (d, 1H, *J* = 1.9 Hz, H_2-quinoline), 7.96 (d, 1H, *J* = 8.4 Hz, H_8-quinoline), 7.94 (d, 1H, *J* = 1.9 Hz, H_4-quinoline), 7.57–7.63 (m, 4H, $(CH_3)_2NC_6H_4CO_2$, H_5 and H_7-quinoline), 7.49 (m, 1H, H_6-quinoline), 7.07 (t, 1H, *J* = 1.3 Hz, C*H*=C), 6.38 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.59 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 4.38 (AB d, 1H, *J* = 11.8 Hz, CO_2CHH), 3.77 (AB q, 2H, *J* = 12.0 Hz, $HOCH_2$), 3.71 (br s, 2H, CH_2-lactone), 2.92 (s, 6H, $N(CH_3)_2$); ^{13}C NMR (100 MHz, $CDCl_3$/CD_3OD): δ 172.66, 166.48, 153.50, 150.66, 148.95, 145.93, 136.20, 134.46, 131.12, 130.07, 129.65, 127.99, 127.75, 127.71, 127.01, 114.90, 110.52, 89.00, 63.01, 62.54, 39.75, 28.96; IR (neat): 3428 (OH), 1759 (CO), 1684 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 433.2 (MH^+, 100%); Anal. ($C_{25}H_{24}N_2O_5$•$0.6H_2O$) C, H, N.

12g-*E*—white solid, m.p: 92–94°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.70 (dm, 1H, *J* = 4.8 Hz, H_6-pyridine), 7.92 (m, 2H, *J* = 2.1, 9.0 Hz, $CH_3OC_6H_4CO_2$), 7.73 (td, 1H, *J* = 7.7, 1.8 Hz, H_4-pyridine), 7.52 (t, 1H, *J* = 3.0 Hz, C*H*=C), 7.42 (d, 1H, *J* = 7.7 Hz, H_3-pyridine), 7.24 (ddd, *J* = 7.7, 4.7, 1.1 Hz, H_5-pyridine), 6.87 (m, 2H, $CH_3OC_6H_4CO_2$), 4.59 (AB d, 1H, *J* = 12.0, Hz, CO_2CHH), 4.44 (AB d, 1H, *J* = 12.0, Hz, CO_2CHH), 3.84–3.88 (m, 4H, $CH_3OC_6H_4$, HOC*H*H), 3.79 (AB d, 1H, *J* = 12.2 Hz, HOCH*H*), 3.55 (dd, 1H, *J* = 19.7, 3.0 Hz, C*H*H-lactone), 3.47 (dd, 1H, *J* = 19.7, 3.0 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.32, 166.21, 163.88, 153.71, 150.13, 136.74, 134.37, 132.04, 129.46, 127.13, 123.59, 121.66, 113.88, 84.54, 65.98, 65.11, 55.61, 33.71; IR (neat): 3421 (OH), 1751 (CO), 1714 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 370.1 (MH^+, 75%), 135.1 (MH^+, 100%); Anal. ($C_{20}H_{19}NO_6$•$0.1H_2O$) C, H, N.

12g-*Z*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.47 (br d, 1H, *J* = 3.7 Hz, H_6-pyridine), 7.89 (m, 2H, $CH_3OC_6H_4CO_2$), 7.59 (td, 1H, *J* = 7.7, 1.7 Hz, H_4-pyridine), 7.14–7.23 (m, 3H, C*H*=C, H_3 and H_5-pyridine), 6.89 (m, 2H, $CH_3OC_6H_4CO_2$), 3.57 (AB q, 2 H, *J* = 12.0 Hz, CO_2CH_2), 2.81–2.89 (m, 5H, $HOCH_2$, $CH_3OC_6H_4$) 2.81 (br s, 2H, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.25, 165.98, 163.94, 149.04, 148.81, 137.74, 134.20, 132.01, 124.00, 122.39, 121.51, 113.93, 110.18, 88.30, 63.61, 63.44, 55.63, 33.91; IR (neat): 3343 (OH), 1760 (CO), 1714 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 370.1 (MH^+, 100%); Anal. ($C_{20}H_{19}NO_6$•0.1H_2O) C, H, N.

12h-*E*—white solid, m.p: 139–140°C; ^{1}H NMR (400 MHz, $CDCl_3$/CD_3OD): δ 8.67 (br d, 1H, *J* = 1.2 Hz, H_2-pyridine), 8.53 (dd, 1H, *J* = 4.8, 1.4 Hz, H_6-pyridine), 7.80–7.83 (m, 2H, $CH_3OC_6H_4CO_2$), 7.77 (dm, 1H, *J* = 8.0 Hz, H_4-pyridine), 7.47 (t, 1H, *J* = 2.9 Hz, C*H*=C), 7.38 (dd, 1H, *J* = 8.0, 4.8 Hz, H_5-pyridine), 6.83 (m, 2H, $CH_3OC_6H_4CO_2$), 4.44 (s, 2H, CO_2CH_2), 3.83 (AB d, *J* = 12.2 Hz, HOC*H*H), 3.80 (s, 2H, $CH_3OC_6H_4$), 3.74 (AB d, *J* = 12.2 Hz, HOCH*H*), 3.30 (dd, 1H, *J* = 17.9, 2.9 Hz, CH*H*-lactone), 3.09 (dd, 1H, *J* = 17.9, 2.9 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.10, 165.94, 163.82, 150.02, 149.39, 137.18, 132.27, 131.67, 130.84, 128.24, 124.22, 121.21, 113.75, 84.59, 65.93, 64.04, 55.38, 32.08; IR (neat): 3401 (OH), 1709 (CO), 1652 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 370.1 (100%); Anal. ($C_{20}H_{19}NO_6$•0.1H_2O) C, H, N.

12h-*Z*—yellow solid, m.p: 155–157°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.49 br (s, 1H, H_2-pyridine), 8.43 (br d, 1H, *J* = 4.9 Hz, H_6-pyridine), 7.84 (m, 2H, $CH_3OC_6H_4CO_2$), 7.55 (br d, 1H, *J* = 7.8 Hz, H_4-pyridine), 7.18 (dd, 1H, *J* = 7.7, 5.0 Hz, H_5-pyridine), 7.02 (br s, 1H, C*H*=C), 6.87 (m, 2H, $CH_3OC_6H_4CO_2$), 4.53 (AB d, 1H, *J* = 12.0 Hz, CO_2CHH), 4.49 (AB d, 1H, *J* = 12.0 Hz, CO_2CHH), 3.84 (s, 3H, $CH_3OC_6H_4$), 3.80 (AB q, 2H, *J* = 12.0 Hz, $HOCH_2$), 3.59 (br s, 2H, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.89, 165.98, 164.07, 148.89, 148.41, 147.06, 137.96, 135.08, 133.47, 131.98, 124.20, 121.30, 114.05, 88.47, 63.59, 63.25, 55.68, 29.26; IR (neat): 3094 (OH), 1756 (CO), 1607 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 370.1 (MH^+, 100%); Anal. ($C_{20}H_{19}NO_6$) C, H, N.

12i-*E*—white solid, m.p: 164–166°C; ^{1}H NMR (400 MHz, DMSO- 8.68 (m, 2H, d_6): δ H_2 and H_6-pyridine), 7.78 (m, 2H, $CH_3OC_6H_4CO_2$), 7.57 (m, 2H, H_3 and H_5-pyridine), 7.42 (t, 1H, *J* = 2.9 Hz, C*H*=C), 7.00 (m, 2H, $CH_3OC_6H_4CO_2$), 5.40 (br s, 1H, $HOCH_2$), 4.44 (AB q, 2H, *J* = 11.9, Hz, CO_2CH_2), 3.82 (s, 3H, $CH_3OC_6H_4$), 3.68–3.70 (m, 2H, $HOCH_2$), 3.28–3.29 (m, 2H, CH_2-lactone); ^{13}C NMR (100 MHz, DMSO-d_6): δ 170.14, 164.84, 163.34, 150.27, 150.22, 141.45, 131.82, 131.47, 131.37, 131.27, 131.20, 123.65, 123.56, 121.21, 114.12, 114.08, 84.65, 66.14, 63.24, 31.94; IR (neat): 3164 (OH), 1750 (CO), 1710 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 370.1 (MH^+, 100%); Anal. ($C_{20}H_{19}NO_6$•0.4H_2O) C, H, N.

12i-*Z*—yellow solid, m.p: 156–158°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.38 (br d, 2H, *J* = 6.0 Hz, H_2 and H_6-pyridine), 7.86 (m, 2H, $CH_3OC_6H_4CO_2$), 7.09 (m, 2H, H_3 and H_5-pyridine), 7.05 (t, 1H, *J* = 1.4 Hz, C*H*=C), 6.89 (m, 2H, $CH_3OC_6H_4CO_2$), 4.67 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.51 (AB d, 1H, *J* = 11.9 Hz, CO_2CH), 3.86 (overlapping s and AB q, 5H, *J* ≈ 12 Hz, $CH_3OC_6H_4$, $HOCH_2$), 3.58 (br s, 2H, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.93, 165.94, 164.09, 149.64, 148.64, 146.64, 134.40, 131.92, 124.30, 121.28, 114.04, 88.62, 63.63, 63.20, 55.67, 31.30; IR (neat): 3095 (OH), 1758 (CO), 1705 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 370.1 (MH^+, 100%); Anal. ($C_{20}H_{19}NO_6$) C, H, N.

12j-*E*—white solid, m.p: 90–91°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.13 (d, 1H, *J* = 8.4 Hz, H_4-quinoline), 8.17 (d, 1H, *J* = 8.5 Hz, H_5-quinoline), 7.72–7.78 (m, 3H, H_8-quinoline, $CH_3OC_6H_4CO_2$), 7.65 (m, 1H, H_7-quinoline), 7.59 (t, 1H, *J* = 3.0 Hz, C*H*=C), 7.49 (m, 1 H, H_6-quinoline), 7.47 (d, 1H, *J* = 8.4 Hz, H_3-quinoline), 6.75 (m, 2H, $CH_3OC_6H_4CO_2$), 4.46

(AB d, 1H, *J* = 12.0 Hz, CO_2CHH), 4.40 (AB d, 1H, *J* = 12.0 Hz, CO_2CHH), 3.80 (AB d, 1H, *J* = 12.2 Hz, $HOCHH$), 3.73 (AB d, 1H, *J* = 12.2 Hz, $HOCHH$), 3.72 (s, 3H, $OCH_3C_6H_4$), 3.67 (br s, 1H, $HOCH_2$), 3.60 (dd, 1H, *J* = 19.7, 3.0, Hz, C*H*H-lactone), 3.53 (dd, 1H, *J* = 19.7, 3.0 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3/CD_3OD$): δ 171.75, 166.07, 163.68, 153.33, 147.79, 137.07, 133.63, 131.68, 130.29, 129.29, 127.64, 127.57, 127.32, 123.39, 121.41, 113.69, 85.24, 66.13, 64.45, 55.34, 33.47; IR (neat): 3381 (OH), 1731 (CO), 1715 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 420.2 (MH^+, 73%), 135.1 (MH^+, 100%); Anal. ($C_{24}H_{21}NO_6 \cdot H_2O$) C, H, N.

12j-*Z*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.99 (irregular t, 2H, *J* ≈ 8 Hz, H_4 and H_5-quinoline), 7.79 (m, 2H, $CH_3OC_6H_4CO_2$), 7.74 (dd, 1H, *J* = 8.4, 1.3 Hz, H_8-quinoline), 7.66 (m, 1H, H_7-quinoline), 7.49 (m, 1H, H_6-quinoline), 7.29 (d, 1H, *J* = 8.4 Hz, H_3-quinoline), 7.24 (t, 1H, , *J* = 1.3 Hz, C*H*=C), 6.76 (m, 2H, $CH_3OC_6H_4CO_2$), 4.62 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.54 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 3.98 (br AB d, 2H, $HOCH_2$), 3.89 (br AB q, 2H, CH_2-lactone), 3.81 (s, 3H, OCH_3); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.45, 165.86, 163.79, 157.32, 148.94, 147.56, 137.39, 134.17, 131.83, 130.00, 128.61, 127.68, 127.06, 126.56, 121.60, 121.38, 113.76, 88.49, 63.51, 63.33, 55.55, 34.70; IR (neat): 3354 (OH), 1759 (CO), 1713 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 420.1 (MH^+, 100%); Anal. ($C_{21}H_{21}NO_6 \cdot 0.5H_2O$) C, H, N.

12k-*E*—white solid, m.p: 161–162°C; ^{1}H NMR (400 MHz, $CDCl_3/CD_3OD$): δ 9.00 (v br s, 1H, H_2-quinoline), 8.22 (s, 1H, H_4-quinoline), 8.06 (m, 1H, H_8-quinoline), 7.88 (br d, 1H, *J* = 7.7 Hz, H_5-quinoline), 7.80 (m, 2H, $CH_3OC_6H_4CO_2$), 7.74 (br t, 1H, *J* = 6.8 Hz, H_6-quinoline), 7.64 (t, 1H, *J* = 2.5 Hz, C*H*=C), 7.57 (dd, 1H, *J* = 8.1, 6.9 H_7-quinoline), 6.83 (m, 2H, $CH_3OC_6H_4CO_2$), 4.45 (s, 2H, CO_2CH_2), 3.84 (AB d, 1 H, *J* = 12.2 Hz, $HOCHH$), 3.73–3.77 (overlapping s and AB d, 4H, $HOCHH$, OCH_3), 3.41 (AB d, *J* = 17.8, 2.5 Hz, C*H*H-lactone), 3.18 (AB d, *J* = 17.8, 2.5 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3/CD_3OD$): δ 171.15, 166.03, 163.94, 163.91, 137.60, 132.89, 131.87, 131.56, 128.79, 128.77, 128.75, 128.71, 128.66, 128.03, 127.78, 121.35, 113.88, 84.60, 66.00, 64.38, 55.55, 32.45; IR (neat): 3393 (OH), 1748 (CO), 1714 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 420.1 (MH^+, 100%); Anal. ($C_{24}H_{21}NO_6$) C, H, N.

12k-*Z*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.76 (d, 1H, *J* = 1.7 Hz, H_2-quinoline), 8.04 (d, 1H, *J* = 8.4 Hz, H_5-quinoline), 7.97 (s, 1H, H_4-quinoline), 7.74 (d, 2H, *J* = 9.1 Hz, $CH_3OC_6H_4CO_2$), 7.63–7.67 (m, 2H, H_8-quinoline, H_7-quinoline), 7.48 (irregular t, 1H, *J* ≈ 7 Hz, H_6-quinoline), 7.12 (s, 1H, C*H*=C), 6.71 (d, 2H, *J* = 9.1 Hz, $CH_3OC_6H_4CO_2$), 4.63 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.49 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 3.88 (br s, 2H, $HOCH_2$), 3.78 (s, 3H, $CH_3OC_6H_4$), 3.74 (br s, 2H, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.54, 165.77, 163.65, 150.58, 148.76, 145.90, 136.40, 134.65, 131.42, 130.09, 129.81, 127.98, 127.82, 127.68, 127.18, 121.00, 113.66, 88.79, 63.05, 63.00, 55.31, 28.99; IR (neat): 3396 (OH), 1758 (CO), 1715 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 420.1 (MH^+, 100%); Anal. ($C_{24}H_{21}NO_6$) C, H, N.

12m-*E*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.67 (dm, 1H, *J* = 4.8 Hz, H_6-pyridine), 7.72 (td, 1H, *J* = 7.7, 1.9 Hz, H_4-pyridine), 7.48 (t, 1H, *J* = 3.0 Hz, C*H*=C), 7.42 (br d, 1H, *J* = 7.7 Hz, H_3-pyridine), 7.23 (ddd, 1H, *J* = 7.7, 4.8, 1.0 Hz, H_5-pyridine), 4.29 (AB q, 2H, *J* = 11.9, Hz, CO_2CH_2), 3.80 (AB d, 1H, *J* = 12.2 Hz, $HOCHH$), 3.72 (AB d, 1H, *J* = 12.2 Hz, $HOCHH$), 3.44 (dd, 1H, *J* = 19.7, 3.0 Hz, C*H*H-lactone), 3.38 (dd, 1H, *J* = 19.7, 3.0 Hz, CH*H*-lactone), 2.31–2.38 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.46–1.55 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.32–1.37 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.15–1.24 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$-), 0.79 and 0.75 (t, 3H, *J* = 7..3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.33, 171.32, 153.79,

150.09, 136.65, 134.09, 129.61, 127.10, 123.48, 84.42, 65.47, 65.23, 45.34, 34.55, 33.55, 20.69, 14.01, 13.97; IR (neat): 3458 (OH), 1752 (CO), 1734 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 362.2 (MH^+, 100%); Anal. ($C_{20}H_{27}NO_5$•$0.2H_2O$) C, H, N.

12m-*Z*—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.53 (d, 1H *J* = 4.1 Hz, H_6-pyridine), 7.69 (td, 1H, *J* = 7.6, 1.0 Hz, H_4-pyridine), 7.32 (d, 1H, *J* = 7.6 Hz, H_3-pyridine), 7.22 (m, 1H, H_5-pyridine), 7.12 (d, 1H, *J* = 1.1 Hz, C=C*H*), 4.33 (AB q, 2H, *J* = 11.6 Hz, CO_2CH_2), 3.77 (s, 2H, HOCH_2), 3.82 (s, 2H, CH_2-lactone), 3.18 (br s, 1 H, *H*OCH_2), 2.31–3.38 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.47–1.57 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.33–1.42 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.22 (sextuplet, 4 H, *J* 7.4 Hz, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.86 (overlapping t, 6H, *J* = 7.3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.22, 172.10, 156.39, 148.84, 137.98, 134.05, 124.24, 122.52, 87.94, 63.56, 63.00, 45.20, 34.52, 33.84, 20.72, 20.70, 14.11; IR (neat): 3357 (OH), 1761 (CO), 1735 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 362.2 (MH^+, 100%); Anal. ($C_{20}H_{27}NO_5$•$0.5H_2O$) C, H, N.

12n-*E*—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.77 (br s, 1H, H_2-pyridine), 8.61 (br s, 1H, H_6-pyridine), 7.47 (d, 1H, *J* = 7.6 Hz, H_4-pyridine), 7.53 (br irregular t, 1H, C*H*=C), 7.40 (br dd, 1H, *J* = 7.6, 4.7 Hz, H_5-pyridine), 4.28 (AB q, 2H, *J* = 12.0 Hz, CO_2CH_2), 3.82 (AB d, 1H, *J* = 12.1 Hz, HOC*H*H), 3.73 (AB d, 1H, *J* = 12.1 Hz, HOCH*H*), 3.29 (dd, 1H, *J* = 17.9, 2.9 Hz, C*H*H-lactone), 3.03 (dd, 1H, *J* = 17.9, 2.9 Hz, CH*H*-lactone), 2.32–2.38 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.46–1.56 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.32–1.41 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.14–1.26 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.77 and 0.81 (t, 6H, *J* = 7.3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.26, 170.54, 150.89, 150.39, 136.77, 133.18, 127.35, 124.01, 83.88, 65.37, 64.77, 45.31, 34.55, 34.53, 32.33, 20.76, 20.72, 14.03, 14.00; IR (neat): 3459 (OH), 1735 (CO), 1655 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 362.3 (MH^+, 100%); Anal. ($C_{20}H_{27}NO_5$) C, H, N.

12n-*Z*—colorless oil; ^1H NMR (400 MHz, $CDCl_3$): δ 8.84 (br s, 1H, H_2-pyridine), 8.56 (br s, 1H, H_6-pyridine), 7.97 (d, 1H, *J* = 7.9 Hz, H_4-pyridine), 7.53 (dm, 1H, *J* = 7.9 Hz, H_5-pyridine), 7.19 (s, 1H, C=C*H*-), 4.35 (AB q, 2H, *J* = 11.9, CO_2CH_2), 3.82 (AB d, 1H, *J* = 11.8 Hz, HOC*H*H), 3.70–3.79 (m, 3H, HOCH*H*, CH_2-lactone), 2.32–3.39 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.49–1.58 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.35–1.43 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.19–1.29 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.87 and 0.88 (t, 3H, *J* = 7.2 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.13, 171.76, 149.74, 146.47, 144.04, 141.38, 133.66, 110.19, 88.34, 63.22, 62.94, 45.20, 34.54, 29.30, 20.75, 20.72, 14.12; IR (neat): 3495 (OH), 1735 (CO), 1662 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 362.3 (MH^+, 100%); Anal. ($C_{20}H_{27}NO_5$) C, H, N.

12o-*E*—yellow solid, m.p: 83–86°C; ^1H NMR (400 MHz, CD_3OD): δ 8.67 (m, *J* 2H, H_2 and H_6-pyridine), 7.66 (m, 2H, H_3 and H_5-pyridine), 7.47 (t, 1H, *J* = 3.0 Hz, C*H*=C), 4.31 (AB q, 2H, *J* = 12.0 Hz, CO_2CH_2), 3.80 (AB d, 1H, *J* = 12.0 Hz, HOC*H*H), 3.72 (AB d, 1H, *J* = 12.0 Hz, HOCH*H*), 3.34 (AB dd, 1H, *J* = 18.6, 3.0 Hz, C*H*H-lactone), 3.18 (AB d, 1H, *J* = 18.6, 3.0 CH*H*-lactone), 2.29–2.36 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.43–1.50 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.30–1.41 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.14–1.24 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.77 and 0.79 (overlapping t, 6H, *J* = 7.2 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, CD_3OD): δ 177.05, 172.01, 150.19, 145.06, 134.12, 132.78, 132.71, 125.65, 125.61, 86.08, 66.85, 65.03, 46.62, 35.73, 35.70, 33.25, 21.66, 21.58, 14.20, 14.19; IR (neat): 3164 (OH), 1759 (CO), 1722 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 362.2 (MH^+, 100%); Anal. ($C_{20}H_{27}NO_5$•$0.7H_2O$) C, H, N.

12o-*Z*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.52 (d, 2H, $J \approx 6.0$ Hz, and H_2 H_6-pyridine), 7.23 (d, 2H, $J \approx 6.0$ Hz, H_3 and H_5-pyridine), 6.99 (irregular t, 1H, $J < 1$ Hz, C*H*=C), 4.38 (AB d, 1H, $J = 11.9$ Hz, CO_2CHH), 4.30 (AB d, 1H, $J = 11.9$ Hz, CO_2CHH), 3.79 (s, 2H, $HOCH_2$), 3.64 (s, 2H, CH_2-lactone), 2.78 (br s, 1H, $HOCH_2$), 2.31–3.38 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.47–1.55 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.34–1.43 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.19–1.28 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.87 and 0.88 (t, 6H, $J = 7.3$ Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.21, 171.72, 149.27, 148.74, 147.34, 134.32, 124.58, 110.18, 87.99, 63.56, 62.96, 45.22, 34.52, 31.40, 20.75, 20.72, 14.11, 14.10; IR (neat): 3179 (OH), 1761 (CO), 1735 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 362.2 (MH^+, 100%); Anal. ($C_{20}H_{27}NO_5 \cdot 0.2H_2O$) C, H, N.

12p-*E*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.17 (d, 1H, $J = 8.2$ Hz, H_4-quinoline), 8.09 (d, 1H, $J = 8.4$ Hz, H_5-quinoline), 7.81 (dd, 1H, $J = 8.4$, 1.2 Hz, H_8-quinoline), 7.73 (m, 1H, H_7-quinoline), 7.65 (t, 1H, $J = 3.1$ Hz, C*H*=C), 7.56 (m, 1H, H_6-quinoline), 7.51 (d, 1H, $J = 8.4$ Hz, H_3-quinoline), 4.34 (AB q, 2H, $J = 12.0$ Hz, CO_2CH_2), 3.86 (AB d, 1H, $J = 12.2$ Hz, HOC*H*H), 3.77 (AB d, 1H, $J = 12.2$ Hz, HOCH*H*), 3.64 (dd, 1H, $J = 20.0$, 3.1 Hz, C*H*H-lactone), 3.03 (dd, 1H, $J = 20.0$, 3.1 Hz, CH*H*-lactone), 2.50 (br s, 1 H, $HOCH_2$), 2.32–3.39 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.47–1.56 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.29–1.39 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.09–1.26 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.71 and 0.77 (t, 6H, $J = 7.3$ Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.37, 171.19, 153.68, 148.39, 136.69, 134.06, 131.12, 130.13, 130.00, 127.67, 127.63, 127.36, 124.00, 84.59, 65.48, 65.27, 45.53, 34.58, 34.55, 33.87, 20.70, 14.00, 13.94; IR (neat): 3364 (OH), 1757 (CO), 1734 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 412.3 (MH^+, 98%), 57.1(MH^+, 100%); Anal. ($C_{24}H_{29}NO_5 \cdot 0.2H_2O$) C, H, N.

12p-*Z*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.12 (d, 1H, $J = 8.4$ Hz, H_4-quinoline,), 8.02 (d, 2H, $J = 8.4$ Hz, H_5-quinoline), 7.80 (dd, 1H, $J = 8.4$, 1.3 Hz, H_8-quinoline), 7.70 (m, 1H, H_7-quinoline), 7.52 (m, 1H, H_6-quinoline), 7.39 (d, 1H, $J = 8.4$ Hz, H_3-quinoline), 7.15 (irregular t, 1H, $J \approx 1.5$ Hz, C*H*=C), 4.34 (AB q, 1H, $J = 12.1$ Hz, CO_2CH_2), 4.03 (dd, 1H, $J = 16.3$, 1.5 Hz, C*H*H-lactone), 3.98 (dd, 1H, $J = 16.3$, 1.5 Hz, CH*H*-lactone), 3.80 (s, 2H, $HOCH_2$), 2.28–3.35 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.44–1.54 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.29–1.38 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.15–1.25 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.83 and 0.85 (t, 6H, $J = 7.3$ Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.20, 172.24, 157.22, 148.80, 137.53, 134.20, 130.15, 128.60, 127.73, 127.16, 126.71, 121.74, 88.00, 63.52, 62.97, 45.18, 34.61, 34.47, 20.67, 14.06, 14.05; IR (neat): 3460 (CO), 1762 (CO), 1736 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 412.2 (MH^+, 100%); Anal. ($C_{24}H_{29}NO_5 \cdot 0.4H_2O$) C, H, N.

12q-*E*—yellow solid, m.p: 113–114°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.04 (br s, 1H, H_2-quinoline), 8.24 (br d, 1H, $J = 1.6$ Hz, H_4-quinoline), 8.12 (d, 1H, $J = 8.4$ Hz, H_5-quinoline), 7.86 (br d, 1H, $J = 8.4$ Hz, H_8-quinoline), 7.78 (m, 1H, H_7-quinoline), 7.70 (t, 1H, $J = 3.0$ Hz, C*H*=C), 7.61 (m, 1H, H_6-quinoline), 4.36 (AB d, 1H, $J = 12.0$ Hz, CO_2CHH), 4.30 (AB d, 1H, $J = 12.0$ Hz, CO_2CHH), 3.88 (AB d, 1H, $J = 12.2$ Hz, HOC*H*H), 3.78 (AB d, 1H, $J = 12.2$ Hz, HOCH*H*), 3.42 (dd, 1H, $J = 17.8$, 3.0 Hz, C*H*H-lactone), 3.15 (dd, 1H, $J = 17.8$, 3.0 Hz, CH*H*-lactone), 2.32–3.39 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.46–1.56 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.31–1.40 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.12–1.26 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.74 and 0.79 (t, 6H, $J = 7.3$ Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.30, 170.71, 150.92, 150.89, 147.92, 137.20, 133.39, 131.29, 129.35, 128.53, 127.84, 127.65, 127.09, 83.93, 65.41, 64.79, 45.29, 34.55, 34.51, 32.50, 20.75, 20.71, 14.03, 13.97; IR (neat): 3367 (OH), 1734 (CO), 1655 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 412.2 (MH^+, 100%); Anal. ($C_{24}H_{29}NO_5 \cdot 0.8H_2O$) C, H, N.

12q-*Z*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.84 (br d, 1H, *J* = 2.0 Hz, H_2-quinoline), 8.10–8.12 (m, 2H, H_5 and H_4-quinoline), 7.79 (br dd, 1H, *J* = 8.2, 1.2 Hz, H_8-quinoline), 7.71 (m, H_6-quinoline), 7.56 (m, 1H, H_7-quinoline), 7.02 (t, 1H, *J* = 1.5 Hz, C*H*=C), 4.37 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.29 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 3.81 (br s, 2H, CH_2-lactone), 3.78 (s, 2H, $HOCH_2$), 2.27–3.34 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.44–1.54 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.29–1.38 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.14–1.25 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.83 and 0.84 (overlapping t, 6H, *J* = 7.3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.16, 171.94, 150.78, 148.52, 146.19, 136.71, 135.20, 130.08, 128.39, 128.16, 127.76, 127.51, 88.07, 63.51, 62.96, 45.18, 34.47, 29.46, 20.71, 20.67, 14.09, 14.06; IR (neat): 3298 (OH), 1757 (CO), 1735 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 412.2 (MH^+, 100%); Anal. ($C_{24}H_{29}NO_5 \cdot 0.3H_2O$) C, H, N.

12s-*E*—colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.68 (br d, 1H, *J* = 4.6 Hz, H_6-pyridine), 7.72 (m, 1H, H_4-pyridine), 7.47 (irregular t, 1H, *J* ≈ 3.0 Hz, C=C*H*-), 7.41 (br d, 1H, *J* = 7.8 Hz, H_3-pyridine), 7.22–7.25 (m, 1H, H_5-pyridine), 4.32 (dd, 1H, *J* = 11.9, < 1.0 Hz, CO_2CHH), 4.23 (dd, 1H, *J* = 11.9, < 1.0 Hz, CO_2CHH), 3.80 (AB d, 1H, *J* = 12.2 Hz, $HOCHH$), 3.72 (AB d, 1H, *J* = 12.2 Hz, $HOCHH$), 3.47 (dd, 1H, *J* = 19.8, 3.0 Hz, C*H*H-lactone), 2.84 (dd, 1H, *J* = 19.8, 3.0 Hz, CH*H*-lactone), 2.20 (irregular d, 2H, *J* ≈ 6.4 Hz, $CH_2CH[CH_2CH(CH_3)_2]_2$), 1.85–1.92 (septuplet, 1H, *J* ≈ 6.7 Hz, $CH_2CH[CH_2CH(CH_3)_2]_2$), 1.51–1.58 (m, 2H, $CH_2CH[CH_2CH(CH_3)_2]_2$), 0.98–1.13 (m, 4H, $CH_2CH[CH_2CH(CH_3)_2]_2$), 0.79–0.83 (m, 12H, $CH_2CH[CH_2CH(CH_3)_2]_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 173.36, 171.21, 153.69, 149.98, 136.82, 134.07, 129.59, 127.14, 123.56, 84.28, 65.48, 65.19, 44.13, 39.47, 33.54, 30.73, 25.23, 22.95, 22.93, 22.68, 22.64; IR (neat): 3450 (OH), 1737 (CO), 1663 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 404.2 (MH^+, 100 %); Anal. ($C_{23}H_{33}NO_5$) C, H, N.

12t-*E*—yellow solid, m.p: 111–112°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.94 (t, 1H, *J* = 2.6 Hz, C*H*=C), 7.82 (dm, 1H, *J* = 7.8 Hz, H_4-indole), 7.24–7.37 (m, 4H, H_2, H_5, H_6 and H_7-indole), 4.34 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.28 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 3.85 (s, 3H, CH_3N), 3.77 (AB d, 1H, *J* = 12.1 Hz, $HOCHH$), 3.74 (AB d, 1H, *J* = 12.1 Hz, $HOCHH$), 3.05 (dd, 1H, *J* = 17.2, 2.6 Hz, C*H*H-lactone), 2.84 (dd, 1H, *J* = 17.2, 2.6 Hz, CH*H*-lactone), 2.22 (irregular d, 2H, *J* = 6.5 Hz, $CH_2CH[CH_2CH(CH_3)_2]_2$), 1.87–1.93 (septuplet, 1H, *J* ≈ 6.8 Hz, $CH_2CH[CH_2CH(CH_3)_2]_2$), 1.50–1.59 (m, 2H, $CH_2CH[CH_2CH(CH_3)_2]_2$), 1.00–1.11 (m, 4H, $CH_2CH[CH_2CH(CH_3)_2]_2$), 0.77–0.83 (m, 12H, $CH_2CH[CH_2CH(CH_3)_2]_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 173.68, 171.73, 136.89, 130.66, 128.84, 128.04, 123.44, 121.44, 119.06, 119.00, 117.00, 111.95, 109.86, 82.85, 65.63, 65.09, 44.15, 44.12, 39.44, 33.55, 33.32, 30.71, 25.24, 25.21, 22.96, 22.70, 22.62; IR (neat): 3449 (OH), 1737 (CO), 1635 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 456.3 (MH^+, 97%), 455.2 ($M^{+\bullet}$, 100); Anal. ($C_{27}H_{37}NO_5 \cdot 0.1H_2O$) C, H, N.

General Procedure for the Synthesis of 8 (R2 = 1-Methylindole)

This compound was prepared from **4**[26] following a similar protocol described in procedures A and B.

8-*E*—white solid; m.p: 196–197°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.91 (t, 1H, *J* = 2.5 Hz, C*H*=C), 7.86 (d, 1H, *J* = 7.9 Hz, H_5-indole), 7.59–7.62 (m, 8H, H_6-H_8-indole, Ph), 7.27–7.42 (m, 15H, Ph), 7.14 (s, 1H, H_2-indole), 3.87 (s, 3 H, NCH_3), 3.83 (AB q, 4H, 2 × $SiOCH_2$), 2.89 (AB m, 2H, CH_2-lactone), 0.99 (s, 18H, 2 × $SiC(CH_3)_3$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.31, 136.85, 135.77, 135.74, 133.12, 132.96, 130.09, 129.89, 129.88, 128.14, 127.85, 127.05, 123.23, 121.15, 119.46, 119.22, 112.31, 109.73, 85.05, 66.41, 33.58, 33.26, 26.84, 19.38; IR (neat): 1747 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 764.5 (MH^+, 37%), 763

($M^{+\bullet}$, 15%), 135.1 (100%). This material was used in the next step without further attempts to obtain an analytically pure sample.

General Procedure for the Synthesis of 10 (R2 = 1-Methylindole)

A solution of **8** (1 equiv) in tetrahydrofuran (THF, 10 mL/mmol) was treated with $[(CH_3(CH_2)_3]_4F$ (TBAF, 3 equiv). The reaction was stirred at room temperature for 1h and concentrated in vacuo. Purification by silica gel flash column chromatography [CH_2Cl_2-MeOH (0% → 10%)] gave **10** as a yellow solid in 62% yield.

10-*E*—white solid; m.p: 211–212-°C; ^{1}H NMR (400 MHz, DMSO-d_6): δ 7.84 (d, 1H, *J* = 7.9 Hz, H_5-indole), 7.81 (s, 1H, H_2-indole), 7.64 (t, 1H, *J* = 2.7 Hz, C*H*=C), 7.53 (d, 1H, *J* = 8.0 Hz, H_8-indole), 7.28 (m, 1H, H_6-indole), 7.20 (m, 1H, H_7-indole), 5.10 (t, 2H, *J* = 5.7 Hz, 2 × *H*OCH_2), 3.90 (s, 3H, CH_3N), 3.48–3.57 (m, 4H, 2 × HOCH_2) 2.91 (br AB d, *J* = 2.7 Hz, 2H, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.49, 136.48, 131.73, 127.30, 125.26, 122.55, 120.66, 120.10, 118.28, 110.53, 110.41, 85.53, 63.63, 32.98, 31.94; IR (neat): 3259 (OH), 1724 (CO) cm^{-1}, FAB-MS (m/z, relative intensity) 288.2 (MH^+, 10%). This material was used in the next step without further attempt to obtain an analytically pure sample.

General Procedure for the Synthesis of 12 (R_2 = 1-methylindole)

A solution of **10** (1 equiv) in CH_2Cl_2 (16 mL/mmol) was treated with anhydrous pyridine (2 equiv) at room temperature and stirred for 2 h. The reaction temperature was then lowered to 0 °C and the acid chloride (R_1COCl, 1.1 equiv) was added dropwise. The resulting solution was stirred at 0 °C for 30 min to 1 h and then at room temperature until the reaction was considered complete by TLC. The crude solution was then concentrated in vacuo and purified by silica gel flash column chromatography [CH_2Cl_2-MeOH (0% → 10%)] to give **12** and variable amounts of the diacylated product, which was not characterized.

12f-*E*—yellow solid, m.p: 160–162°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.98 (br t, 1H, *J* = 2.6 Hz, C*H*=C), 7.83 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 7.27–7.35 (m, 5H, *indole*), 6.55 (m, 2H, $(CH_3)_2NC_6H_4CO_2$), 4.63 (AB d, 1H, *J* = 12.0, Hz, CO_2CHH), 4.39 (AB d, 1H, *J* = 12.0, Hz, CO_2CHH), 3.86 (s, 3H, NCH_3), 3.80 (s, 2H, HOCH_2), 2.87–3.17 (m, 8H, $(CH_3)_2NC_6H_4$, CH_2-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.92, 167.31, 153.71, 136.91, 131.80, 130.74, 128.87, 128.10, 123.38, 121.37, 119.06, 117.27, 115.67, 111.95, 110.87, 110.17, 109.89, 83.35, 65.67, 64.91, 40.16, 33.62, 33.51; IR (neat): 3396 (OH), 1738 (CO), 1698 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 435.2 (MH^+, 15%), 148.1 (100%); Anal. ($C_{25}H_{26}N_2O_5$•$0.9H_2O$) C, H, N.

12l-*E*—white solid, m.p: 120–122°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.91 (t, *J* = 2.6 Hz, 1H, C*H*=C), 7.81 (m, 2H, $CH_3OC_6H_4CO_2$), 7.78 (dm, 1H, *J* = 8.0 Hz, H_4-indole), 7.19–7.32 (m, 4H, *indole*), 6.75 (m, 2H, $CH_3OC_6H_4CO_2$), 4.59 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.41 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 3.81 (s, 3H, NCH_3), 3.77 (AB q, 2H, *J* = 11.9 Hz, HOCH_2), 3.73 (s, 3 H, CH_3OC$_6H_4$), 3.05 (dd, 1H, *J* = 17.1, 2.6 Hz, C*H*H-lactone), 2.93 (dd, *J* = 17.1, 2.6 Hz, CH*H*-lactone); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.76, 166.31, 163.73, 136.84, 131.80, 130.90, 128.70, 127.96, 123.31, 121.49, 121.29, 118.81, 117.36, 113.78, 111.71, 109.85, 83.80, 66.36, 64.68, 55.43, 33.46, 33.17; IR (neat): 3366 (OH), 1706 (CO), 1636 (CO) cm^{-1}; FAB-MS (m/z, relative intensity) 422.2 (MH^+, 91%), 135.1 (100%); Anal. ($C_{24}H_{23}NO_6$) C, H, N.

12r-*E*—yellow solid; m.p: 125–127-°C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.96 (t, *J* = 2.7 Hz, 1H, CH=C), 7.84 (irregular d, *J* ≈ 7.9 Hz, 2H, H_4-indole), 7.27–7.37 (m, 4H, H_2, H_5, H_6 and H_7-indole), 4.39 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 4.27 (AB d, 1H, *J* = 11.9 Hz, CO_2CHH), 3.87 (s, 3H, NCH_3), 3.79 (AB d, 1H, *J* = 12.1 Hz, HOC*H*H), 3.73 (AB d, 1H, *J* =

12.1 Hz, HOCH*H*), 3.05 (dd, 1H, *J* = 17.1, 2.7 Hz, C*H*H-lactone), 2.84 (dd, 1H, *J* = 17.1, 2.7 Hz, CH*H*-lactone), 2.35–2.42 (m, 1H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.49–1.57 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.36–1.40 (m, 2H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 1.19–1.27 (m, 4H, $(CH_3CH_2CH_2)_2CHCO_2CH_2$), 0.78 and 0.83 (t, 6H, *J* = 7.3 Hz, $(CH_3CH_2CH_2)_2CHCO_2CH_2$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 176.73, 171.68, 136.92, 130.57, 128.89, 128.06, 123.49, 121.48, 119.80, 117.04, 112.04, 109.88, 82.87, 65.50, 65.18, 45.37, 34.56, 33.63, 33.37, 20.76, 14.07, 14.02; IR (neat): 3437 (OH), 1735 (CO), 1637 (CO) cm^{-1}, FAB-MS (m/z, relative intensity) 414.3 (MH^+, 100%) 413.3 ($M^{+\bullet}$, 94.5); Anal. ($C_{24}H_{31}NO_5 \bullet 0.6H_2O$) C, H, N.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

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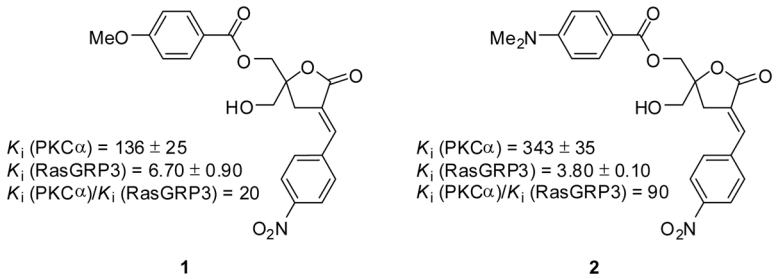
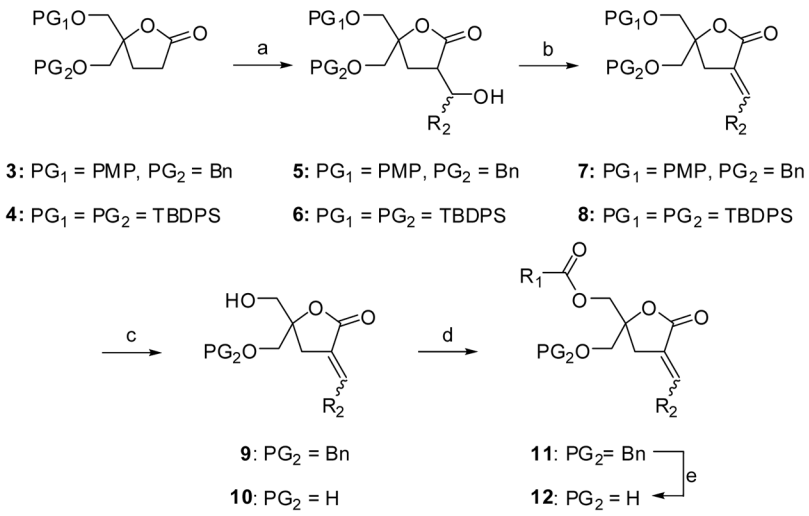


Figure 1.

Chemical structures of DAG-lactones **1** and **2**. K_i values for PKCα and RasGRP3 and K_i (PKCα)/K_i (RasGRP3) ratios.

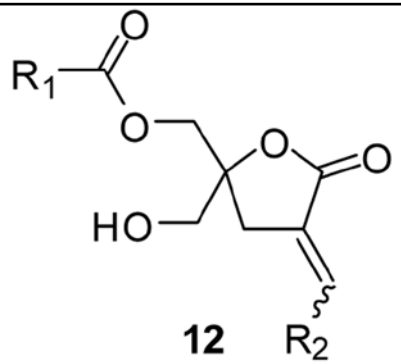


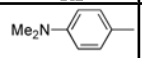
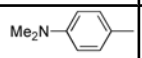
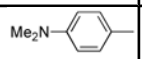
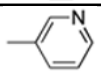
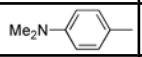
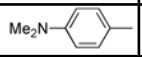
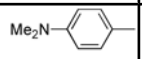
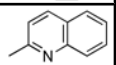
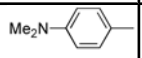
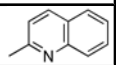
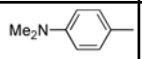
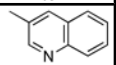
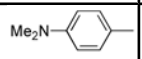
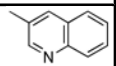
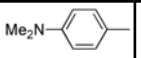
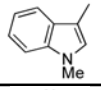
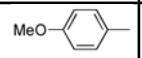
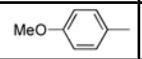
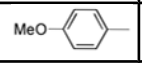
Scheme 1.

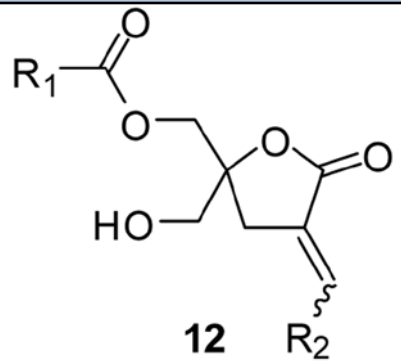
Conditions and reagents: (a) LiHMDS, R_2CHO, THF, −78 °C; (b) Et_3N, MsCl, DBU, CH_2Cl_2, 0°C → rt; (c) (**7**) CAN, CH_3CN, 0 °C; or (**8**) TBAF, THF; (d) (**9**) Et_3N, DMAP, R_1COCl; or (**10**) pyridine, CH_2Cl_2 then R_1COCl, 0 °C; (e) BCl_3, CH_2Cl_2, −78°C.

Table 1

Binding affinities (K_i, nM) for PKCα and RasGRP3 for compounds **12a-l.**



	R1	R2	SLog P	PKCα *Ki* (nM)	PKCα *Z*/*E* (*Ki*)	RasGRP3 *Ki* (nM)	RasGRP3 *Z*/*E* (*Ki*)
12a-*E*			2.0660	1020 ± 100	—	23.8 ± 2.6	—
12b-*E*			2.0660	790 ± 100	43	59 ± 13	33
12b-*Z*			2.0660	34100 ± 3300		1970 ± 360	
12c-*E*			2.0660	1110 ± 200	30	54± 13	44
12c-*Z*			2.0660	33200 ± 4300		2360 ± 150	
12d-*E*			3.2192	150 ± 21	105	11.0 ± 1.9	185
12d-*Z*			3.2192	15800 ± 5400		2040 ± 400	
12e-*E*			3.2192	755 ± 75	6.5	137 ± 16	10
12e-*Z*			3.2192	4880 ± 640		1410 ± 130	
12f-*E*			3.2192	174 ± 18	—	3.7 ± 0.8	—
12g-*E*			2.0086	1130 ± 390	24	35.8 ± 4.8	69
12g-*Z*			2.0086	27100 ± 3000		2470 ± 360	
12h-*E*			2.0086	810 ± 130	26	81 ± 12	68



12

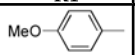
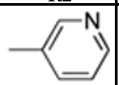
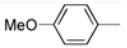
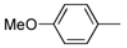
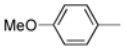
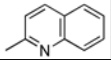
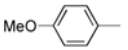
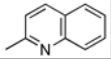
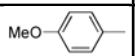
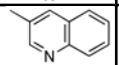
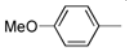
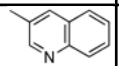
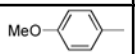
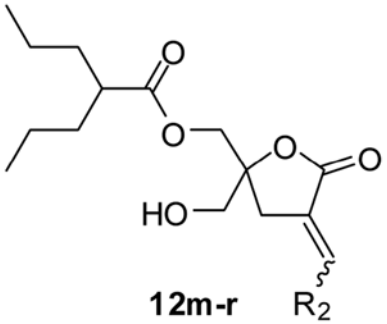
	R1	R2	SLog P	PKCα *Ki* (nM)	PKCα *Z*/*E* (*Ki*)	RasGRP3 *Ki* (nM)	RasGRP3 *Z*/*E* (*Ki*)
12h-*Z*			2.0086	21200 ± 5600		5500 ±1200	
12i-*E*			2.0086	1450 ± 150	18	54.2 ± 7.2	68
12i-*Z*			2.0086	25400 ± 1700		3660 ± 750	
12j-*E*			3.1618	132 ± 8.6	22	8.2 ± 1.1	170
12j-*Z*			3.1618	2940 ± 260		1390 ± 130	
12k-*E*			3.1618	144 ± 20	35	17.4 ± 1.7	52
12k-*Z*			3.1618	5100± 550		907 ± 98	
12l-*E*			3.4645	212 ± 35	—	3.3 ± 1.5	—

Table 2

Binding affinities (K_i, nm) for PKCα and RasGRP3 for compounds **12m-r.**



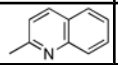
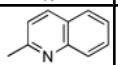
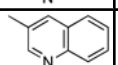
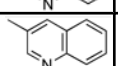
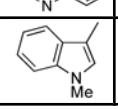
	R_2	Slog P	PKCα *Ki* (nM)	PKCα *Z*/*E* (*Ki*)	RasGRP3 *Ki* (nM)	RasGRP3 *Z*/*E* (*Ki*)
12m-*E*		2.9026	86.3 ± 0.7	16	0.72 ± 0.1	116
12m-*Z*		2.9026	1370 ± 120		83± 12	
12n-*E*		2.9026	76 ± 10	43	1.6 ± 0.1	419
12n-*Z*		2.9026	3270 ± 320		670 ± 70	
12o-*E*		2.9026	627 ± 22	1.4	13.8 ± 1.5	3
12o-*Z*		2.9026	870 ± 280		44 ± 14	
12p-*E*		4.0558	51.9 ± 8.8	1.5	1.7 ± 0.2	3
12p-*Z*		4.0558	78.8 ± 6		4.6 ± 0.6	
12q-*E*		4.0558	13.8 ± 1.7	13	0.52 ± 0.05	62
12q -*Z*		4.0558	177 ± 21		32.2 ± 4.2	
12r-*E*		4.3585	29.7 ± 1.1	—	0.18 ± 0.03	—

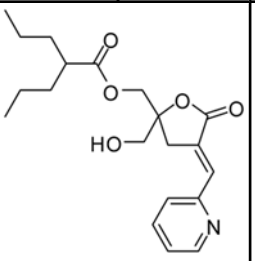
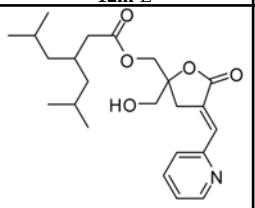
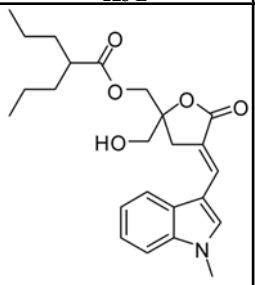
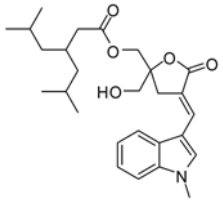
Table 3

Affinity ratios between PKCα and RasGRP3 for compounds **12a-r.**

***E*-isomer**	***Ki* ratio PKCα/RasGRP-3**	***Z*-isomer**	***Ki* ratio PKCα/RasGRP-3**
12a-*E*	43	—	
12b-*E*	13	**12b**-*Z*	20
12c-*E*	19	**12c**-*Z*	14
12d-*E*	14	**12d**-*Z*	8
12e-*E*	6	**12e**-*Z*	3
12f-*E*	47	—	—
12g-*E*	32	**12g**-*Z*	11
12h-*E*	10	**12h**-*Z*	4
12i-*E*	27	**12i**-*Z*	7
12j-*E*	16	**12j**-*Z*	2
12k-*E*	8	**12k**-*Z*	6
12l-*E*	64	—	—
12m-*E*	119	**12m**-*Z*	16
12n-*E*	47	**12n**-*Z*	5
12o-*E*	45	**12o**-*Z*	20
12p-*E*	31	**12p**-*Z*	17
12q-*E*	27	**12q**-*Z*	5
12r-*E*	165	—	—

Table 4

Affinity ratios between PKCα and RasGRP3 for compound **12m-*E*** versus **12s-*E*** and compound **12r-*E*** versus **12t-*E*.**

Compound	SlogP	PKCα *Ki* (nM)	RasGRP-3 *Ki* (nM)	Ratio PKCα/RasGRP-3
 **12m**-*E*	2.9026	86.3 ± 0.7	0.72 ± 0.1	119
 **12s**-*E*	3.7847	4.6 ± 0.5	0.20 ± 0.04	23
 **12r**-*E*	4.3585	29.7± 1.1	0.18± 0.03	165
 **12t**-*E*	5.2406	14.8± 1.0	0.70± 0.02	21