Synthesis of Bicyclic Hemiacetals Catalyzed by Unnatural Densely Substituted γ-Dipeptides

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1 General Remarks

Unless otherwise noted, reagents (6, 7 and 8) and organocatalysts 11-13, 15 and 16 were purchased from commercial suppliers. Nitrodiene 7i and aldehyde 8f were prepared according to literature. Catalysts NO$_2$-X$_L$-1, NH$_2$-X$_L$-2, X$_L$X$_L$-3, X$_L$X$_L$-4, X$_L$X$_L$Me-5, were prepared following our previously described procedures. 3,4,5,6

TLC was performed on 0.25mm silica gel 60 F254 aluminum plates and visualized with UV lamps or potassium permanganate stain. Flash column chromatography was carried out on columns of silica gel 60 (particle size 23-40 μm).

Optical rotations were measured at 589 nm (Sodium line) in a digital polarimeter with a thermally jacketed 5 cm cell at approximately 20 °C. Concentrations are given in g/100 mL.

Infrared spectra were recorded on an Alpha-Bruker FT-IR spectrometer with a single reflection ATR module. Wavenumbers are given in cm$^{-1}$.

High Resolution Mass Spectra (HRMS) analyses were carried out by SGiker services (Central Service of Alava and Bizkaia, University of the Basque Country) and performed on a LC/QTOF, Agilent mass spectrometer using electrospray ionization (ESI) mode.

NMR spectra were recorded at 400 or 500 MHz for $^1$H NMR, 101 or 126 MHz for $^{13}$C NMR and 376 MHz for $^{19}$F NMR using CDCl$_3$, acetone-$d_6$ and methanol-$d_4$ as solvents and TMS as internal standard. The data are reported as s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet or unresolved, bs = broad signal, coupling constant(s) (J) in Hz, integration. $^{13}$C NMR spectra were recorded with $^1$H decoupling. Structural assignments were made with additional information from gCOSY, gHSQC, and gHMBC experiments.

Enantioselectivities were measured by HPLC using chiral stationary phases (Daicel Chiralpak IA/IB/IC/ID). In these experiments the racemic mixtures were analysed in order to establish the enantiomeric parameters of each enantiomer.

For X-Ray diffraction analyses, Agilent Technologies Super-Nova diffractometer was employed, equipped with monochromated Cu kα radiation ($\lambda = 1.54184$ Å) and Atlas CCD detector. Measurements were accomplished at 100 K with the aid of an Oxford Cryostream 700 PLUS temperature device. Data frames were processed (united cell determination, analytical absorption correction with face indexing, intensity data integration and correction for Lorentz and polarization effects) utilizing the Crysalis software package. 7 The structure was solved by Superflip and refined by full-matrix least-squares with SHELXL-97. Final
geometrical calculations were carried out on Mercury\textsuperscript{10} and PLATON\textsuperscript{11} as integrated in WinGX\textsuperscript{12}. Samples were prepared by heating a solution of the compound in a xx yy, followed by slow evaporation.

2 Procedure for the synthesis of NO$_2$-X$_L$-Gly-OMe 14 organocatalyst

Catalysts NO$_2$-X$_L$-Gly-OMe 14 was prepared following our previously described procedures\textsuperscript{3,4,5,6}. To a stirred solution of the corresponding amine (0.8 mmol) in CH$_2$Cl$_2$ (10 mL) was added acid (1.0 mmol), PyBOP (1.0 mmol) and disopropyl ethyl amine (1.4 mmol). The resulting mixture was then stirred until completion of the reaction. Then, the reaction mixture was diluted with CH$_2$Cl$_2$, washed with a 1M HCl solution, saturated aqueous NaHCO$_3$, brine and then dried over Na$_2$SO$_4$. Evaporation of the solvent followed by column chromatography eluting with EtOAc/hexane provided the product described below.

\begin{center}
\begin{tikzpicture}
\node (a) at (0,0) {\includegraphics[width=0.5\textwidth]{methyl2-((2S,3S,4R,5S)-4-nitro-3,5-diphenylpyrrolidine-2-carboxamido)acetate (NO$_2$-X$_L$-Gly-OMe 14)}; \end{tikzpicture}
\end{center}

Yield: 72 mg, 85%, yellow syrup; [$\alpha$]\textsubscript{D} = +86.07 (c 1.15, acetone);

\textbf{FTIR} (neat, cm$^{-1}$): 1744, 1666, 1546, 1208, 698; $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.57 (d, J = 7.3 Hz, 2H, ArH), 7.46 (dd, J = 21.7, 14.7 Hz, 2H, ArH), 7.39 (dd, J = 16.2, 9.0 Hz, 1H, ArH), 7.31 – 7.23 (m, 3H, ArH), 7.23 – 7.18 (m, 2H, ArH), 7.01 (m, 1H, CONH), 5.16 (t, J = 7.7 Hz, 1H, C$_4$H), 4.85 (d, J = 7.9 Hz, 1H, C$_5$H), 4.44 (d, J = 9.5 Hz, 1H, C$_3$H), 4.41 – 4.32 (dd, J = 9.4, 7.6 Hz, 1H, C$_3$H), 3.73 (dd, J = 18.3, 5.2 Hz, 1H, CH$_2$), 3.72 (s, 3H, CO$_2$Me), 3.61 (dd, J = 18.5, 5.0 Hz, 1H, CH$_2$); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 170.2, 170.0, 137.0, 137.0, 135.7, 129.2, 129.1, 128.6, 128.4, 128.2, 126.8, 95.2, 66.6, 64.5, 53.1, 52.4, 40.6; HRMS (ESI) m/z: [M + H]$^+$
Calc for C$_{20}$H$_{22}$N$_2$O$_5$ 384.1559. Found: 384.1567.

3 Screening of different organocatalysts based on proline derivatives for the Michael Addition Reaction

Based on previous studies of our research group\textsuperscript{6} we evaluated different proline derivative organocatalysts in the Michael reaction between cyclohexanone 6a and nitrostyrene 7a in the presence of benzoic acid as additive. The obtained results are shown in Table S1. Reactions were performed under neat conditions using cyclohexanone 6a (0.8 mmol), trans-β-nitrostyrene 7a (0.1 mmol) in presence of the corresponding catalyst (0.03 mmol) and benzoic acid (0.03 mmol).
Under these conditions, L-proline 11 was not very efficient and a low conversion was observed after one day of reaction (Table S1, entry 1). It is interesting to note that Enders and Seki\textsuperscript{13} observed, under different conditions, medium-low ee’s in the Michael reaction between 6a and 7a (18-57%). Similarly, D-prolinol derivative 12 showed low catalytic activity (Table S1, entry 2). Pro-Gly dimer 13 was moderately efficient in the presence of benzoic acid (Table S1, entry 4). However, no noticeable ee was observed. The α–dipeptide X-L-Gly-OH 14 also showed moderate catalytic activity and a modest ee (Table S1, entry 5). These results show the suitability of γ–depeptides 3 and 4 for the Michael-Henry-hemiketalization reaction discussed in this study.

**Table S1.** Michael reaction between cyclohexanone 6a and trans-β-nitrostyrene 7a catalyzed by proline derivatives 11-14.\textsuperscript{a}

| Entry | Catalyst | Time (d) | Conv\textsuperscript{b} (%) | syn:anti\textsuperscript{c} | Yield\textsuperscript{d} (%) | ee\textsuperscript{e} (%) |
|-------|----------|----------|-----------------------------|---------------------------|---------------------------|------------------------|
| 1     | 11       | 1        | 57                          | nd\textsuperscript{f}     | nd                        | nd                     |
| 2     | 12       | 3        | <10%                        | nd                        | nd                        | nd                     |
| 3\textsuperscript{f} | 13       | 7        | 22                          | nd                        | nd                        | nd                     |
| 4     | 13       | 7        | 72                          | 87:13                     | 45                        | 0                      |
| 5     | 14       | 7        | 74                          | 78:22                     | 38                        | 66                     |

\textsuperscript{a}Reactions were conducted under neat conditions using cyclohexanone 6a (0.8 mmol), trans-β-nitrostyrene 7a (0.1 mmol) in the presence of the corresponding catalyst (0.03 mmol) and benzoic acid (0.03 mmol). \textsuperscript{b}Conversions to 8aa were measured by \textsuperscript{1}H NMR of crude reaction mixtures. \textsuperscript{c}Syn:anti ratio was measured by \textsuperscript{1}H NMR of crude reaction mixtures. \textsuperscript{d}Yields refer to isolated pure
Michael adducts. Enantiomeric excesses measured by HPLC correspond to the major syn-diastereomer $(2R,1'S)$-8aa. *nd: not determined because of very low values and/or conversions. $^\circ$The reaction was performed in the absence of PhCO$_2$H. $^\circ$Unreacted 7a was present in the reaction mixture.

4 General Procedure for the One-pot Michael-Henry-Acetalization Reaction

A reaction mixture of $X_L$-$X_L$Me-OMe-4 (121.0 mg, 0.2 mmol, 0.2 eq.), acid derivative (0.2 mmol, 0.2 eq.), ketone 6a-c (1 mmol, 1.0 eq.) and nitroolefins 7a-i (1.1 mmol, 1.1 eq.) in 550 μL of DCM was stirred at room temperature until total consumption of the nitroalkene. This step could be monitored by NMR analysis of reaction mixtures, according to our previously described characterization of Michael adducts obtained via monomeric and dimeric species (see refs. 17 and 18 of the main text). Then, the corresponding aldehyde 8a-f (2.0 mmol, 2 eq.) and triethylamine (30 μL, 0.2 mmol, 0.2 eq.) were successively added and the resulting reaction mixture was allowed to stir at the indicated temperature until total consumption of the intermediate $\gamma$-nitroketone. Afterwards, the crude mixture was evaporated under reduced pressure and purified by flash column chromatography on silica gel (check each compound for conditions). For the racemic compounds, the reactions were carried out using pyrrolidine (80 μL, 1.0 mmol, 1 eq.).

4.1 Screening of different chiral organocatalysts based on primary amines

The catalytic activities of quinidine derivative 15 and bifunctional amine-thiourea 16 were investigated. In both cases, the Michael step required 10 days to achieve less than 30% conversion. Then, ethyl glyoxylate (2 eq.) and triethylamine (0.2 eq) were added and the resulting reaction mixture was allowed to stir at room temperature for 1 day. The final product 10aaa could not be distinguished in the reaction crude and the enantiomeric excess could not be determined in any case (Scheme S1).
Scheme S1. Unsuccessful screening of organocatalyst 15 and 16.

4.2 Procedure for the synthesis of 10aaa at the 5 mmol scale

A reaction mixture of X-L-XL-Me-OMe-4 (302.5 mg, 1 mmol, 0.1 eq.), salicylic acid (XX mg, 0.2 mmol, 0.2 eq.), ketone 6a (5 mmol, 1.0 eq.) and nitroolefins 7a (5.0 mmol, 1.0 eq.) in 2.75 mL of DCM was stirred 3 days at room temperature until total consumption of the nitroalkene. This step could be monitored by NMR analysis of reaction mixtures, according to our previously described characterization of Michael adducts obtained via monomeric and dimeric species (see refs. 17 and 18 of the main text). Then triethylamine (140 μL, 1.0 mmol, 0.2 eq.) and the freshly distilled ethyl glyoxylate 8a (10.0 mmol, 2.0 eq.) were successively added and the resulting reaction mixture was allowed to stir at room temperature 1 day. Afterwards, the crude mixture was evaporated under reduced pressure and purified by flash column chromatography on silica gel (1:2 EtOAc:Hexane mixture) to provided 10aaa (838 mg, 48%).

4.3 Isomerization Reaction for the Synthesis of 10aad’

A reaction mixture of 10aad (343 mg, 1 mmol, 1 eq.) and DBU (150μL, 1 mmol, 1 eq.) in acetonitrile was stirred at room temperature for 16h. Then, the crude mixture was
evaporated under reduced pressure and purified by flash column chromatography on silica gel (1:2 EtOAc:Hexane mixture) to provided 10aad' (234 mg, 68%).

4.4 Studies with Other Cyclic Ketones

After optimizing the reaction conditions, the scope of this process was investigated employing other cyclic ketones. Unfortunately, the reaction presented some restrictions regarding the nature of the nucleophiles. For instance, when tetrahydro-4H-pyran-4-one 6d and cyclohexane-1,3-dione 6e were selected as starting materials, no formation of the intermediate Michael adducts was observed in the presence of salicylic acid (Scheme S2). Changing the acidic additive into TFA did not still show any formation of the Michael adduct. In contrast, when cyclopentanone 6f was employed as precursor of the corresponding nucleophilic enamine species, complex mixtures of diastereomeric adducts 10faa and Michael intermediate syn-9fa were observed (Scheme S2). "H-NMR spectra of the crude reaction mixtures obtained in different experiments showed that previously characterized syn Michael adduct 9fa and different diastereomers of cyclized product 10faa were formed in a ca. 40:60 ratio. Analyses of the intermediate Michael adducts showed a transient 85:15 ratio of the syn and anti diastereomers of 9fa, from which the different isomers of 10faa, together with an unreacted amount of syn-9fa were finally observed in low yield as an inseparable mixture. Therefore, we concluded that cyclopentanone 6f is not a suitable substrate for this reaction.

Scheme S2. Unsuccessful Michael-Henry-acetalization reactions using ketones 6d-f.
Our attempts turned successful when cycloheptanone 6b and 1,4-cyclohexanedione monoethylene acetal 6c were chosen as starting materials. However, small changes were necessary for the proper synthesis of the corresponding derivatives.

Derivative 10baa demanded equimolar amounts of Et₃N for the total consumption of the γ-nitroketone intermediate. Longer reaction times related to catalytic equivalents resulted in a severe decrease in yield. It should be mentioned that the final product was achieved in moderate yield and excellent enantioselectivities, but in a 92:8 mixture of non-separable diastereomers. Such proportion could be explained by the cyclization of both the syn- and anti- Michael adducts.

In the case of the synthesis of 10caa, the Michael step required 7 days to reach full conversion. The following Henry-acetalization step, on the contrary, was completed in 1 hour. Hence, catalyst O₂N-X₅-X₅-Me-O-Me-4 provided the desired 10caa product as a single diastereomer in 62% yield and 89% of enantiomeric excess.

Ethyl (2S,3R,4S,4aR,8aS)-8a-hydroxy-3-nitro-4-phenyloctahydro-2H-chromene-2-carboxylate (10aaa). The title product was obtained from cyclohexanone 6a, trans-β-nitrostyrene 7a and ethyl glyoxylate 8a employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. Yield 72% (251 mg, 0.72 mmol), white solid. m_p = 169-171 °C. [α]_D^{25} = +52.63 (c 0.95, chloroform). FTIR (neat, cm⁻¹) 3507, 1756, 1545, 1313. ¹H NMR (400 MHz, CDCl₃) δ 7.32 (d, J = 7.4 Hz, 3H, ArH), 7.13 (d, J = 7.3 Hz, 2H, ArH), 5.14 (d, J = 3.0 Hz, 1H, C₉H), 5.12 (d, J = 4.4 Hz, 1H, C₈H), 4.33 – 4.13 (m, 2H, CH₂CH₃), 3.52 (dd, J = 12.5, 4.8 Hz, 1H, C⁷H), 2.61 (td, J = 12.2, 3.3 Hz, 1H, C⁶H), 2.09 – 1.97 (m, 2H, CH₂, OH), 1.95 (s, 1H, CH₂), 1.78 (d, J = 13.7 Hz, 1H, CH₂), 1.74 – 1.60 (m, 2H, CH₂), 1.39 (d, J = 14.4 Hz, 1H, CH₂), 1.23 (t, J = 7.2 Hz, 3H, CH₂CH₃), 1.18 – 0.98 (m, 1H, CH₂), 0.92 – 0.79 (m, 1H, CH₂). ¹³C{H} NMR (101 MHz, CDCl₃) δ 167.7 (C=O), 136.2 (ArC), 129.1 (ArC), 128.3 (ArC), 128.2 (ArC), 98.1 (C¹), 86.9 (C⁸), 69.3 (C⁹), 62.3 (CH₂CH₃), 44.1 (C⁷), 38.9 (C⁸), 38.5 (CH₂), 26.2 (CH₂), 25.6 (CH₂), 23.1 (CH₂), 14.1 (CH₂CH₃). HRMS (ESI) m/z: [M+H]^+ Calcd for C₁₈H₂₄NO₆ 350.1603; Found 350.1605. HPLC (Chiralpak IA, Hexane:iPrOH = 95:5, flow rate 1 mL/min, λ = 210 nm), t_R (major) = 21.56 min, t_R (minor) = 31.23 min; ee = 99%.
|   | RT   | Height | Area    | % Area |
|---|------|--------|---------|--------|
| 1 | 21.560 | 772486 | 70549380 | 50.95  |
| 2 | 31.230 | 546319 | 67923484 | 49.05  |

|   | RT   | Height | Area    | % Area |
|---|------|--------|---------|--------|
| 1 | 24.054 | 932234 | 74986663 | 100.0 |
| 2 |        |        |         |        |

*Ethyl (2S,3S,4S,4aR,8aS)-8a-hydroxy-3-nitro-4-phenyloctahydro-2H-chromene-2-carboxylate* (10aa`). The title product was obtained from cyclohexanone 6a, trans-β-nitrostyrene 7a and ethyl glyoxylate 8a employing salicylic acid as additive and 1 equivalent of DBU. Purified on 1:2 EtOAc:Hexane mixture. Yield 65% (226 mg, 0.65 mmol), white solid.

m.p. = 137-139 °C. [α]$_D^{25}$ = -18.28 (c 0.90, chloroform). FTIR (neat, cm$^{-1}$) 3471, 1739, 1550, 1373. $^1$H NMR (400 MHz, CDCl$_3$) δ 7.39 – 7.23 (m, 3H, ArH), 7.18 (d, J = 21.5 Hz, 2H, ArH), 5.20 (d, J = 10.3 Hz, 1H, C$^9$H), 4.88 (dd, J = 11.3, 10.3 Hz, 1H, C$^8$H), 4.34 – 4.09 (m, 2H, CH$_2$CH$_3$), 3.54 (t, J = 11.6 Hz, 1H, C$^7$H), 2.25 (d, J = 1.7 Hz, 1H, OH), 1.94 – 1.68 (m, 4H, C$^6$H, CH$_2$), 1.66 (m, 1H, CH$_2$), 1.62 – 1.52 (m, 1H, CH$_2$), 1.25 (t, J = 7.2 Hz, 3H, CH$_2$CH$_2$), 1.22 – 1.05 (m, 3H, CH$_2$). $^{13}$C{H} NMR (101 MHz, CDCl$_3$) δ 168.4 (C=O), 136.6 (ArC), 129.2 (ArC), 128.2 (ArC), 97.7 (C$^1$), 89.0 (C$^8$), 70.2 (C$^9$), 62.4 (CH$_2$CH$_3$), 46.7 (C$^7$), 46.4 (C$^6$), 38.3 (CH$_2$), 26.2 (CH$_2$), 25.5 (CH$_2$), 23.0 (CH$_2$), 14.0 (CH$_2$CH$_3$). HRMS (ESI) m/z: [M+H]$^+$ Calcd for C$_{18}$H$_{24}$NO$_3$ 350.1603; Found 350.1605. HPLC (Chiralpak IC, Hexane:iPrOH = 95:5, flow rate 1 mL/min, λ = 210 nm), $t_R$ (minor) = 14.87 min, $t_R$ (major) = 24.39 min; ee = 98%.
Ethyl (2S,3R,4S,4aR,8aS)-8a-hydroxy-4-(4-methoxyphenyl)-3-nitrooctahydro-2H-chromene-2-carboxylate (10aba). The title product was obtained from cyclohexanone 6a, trans-4-methoxy-β-nitrostyrene 7b and ethyl glyoxylate 8a employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. Yield 65% (247 mg, 0.65 mmol), pale brown solid. m.p. = 166-168 °C. [α]D25 = +57.84 (c 0.75, chloroform). FTIR (neat, cm⁻¹) 3460, 2939, 1754, 1548, 1514, 1249. ¹H NMR (400 MHz, CDCl₃) δ 7.08 – 6.98 (m, 2H, ArH), 6.85 (d, J = 8.6 Hz, 2H, ArH), 5.12 (d, J = 3.2 Hz, 1H, C⁹H), 5.08 (dd, J = 4.9, 3.2 Hz, 1H, C⁸H), 4.32 – 4.22 (m, 1H, C₂H₂CH₃), 4.22 – 4.13 (m, 1H, C₂H₂CH₃), 3.78 (s, 3H, OCH₃), 3.46 (dd, J = 12.5, 4.8 Hz, 1H, C⁷H), 2.55 (td, J = 12.4, 3.2 Hz, 1H, C⁶H), 2.22 (bs, 1H, OH), 2.04 – 1.87 (m, 2H, CH₂), 1.83 – 1.73 (m, 1H, CH₂), 1.71 – 1.54 (m, 2H, CH₂), 1.42 – 1.35 (m, 1H, CH₂), 1.31 (dt, J = 12.9, 4.0 Hz, 1H, CH₂), 1.23 (t, J = 7.1 Hz, 3H, CH₂CH₃), 1.08 (qd, J = 12.6, 3.4 Hz, 1H, CH₂). ¹³C{H} NMR (126 MHz, CDCl₃) δ 167.7, 159.3, 129.3, 128.2, 114.5, 98.1, 87.2, 69.3, 62.3, 55.3, 43.28, 39.2, 38.5, 26.2, 25.7, 23.1, 14.1. HRMS (ESI) m/z [M+Na]+ Calcd for C₁₉H₂₅NO₇Na 402.1521; Found 402.1514. HPLC (Chiralpak IA, Hexane:iPrOH = 95:5, flow rate 1 mL/min, λ = 210 nm), tᵣ (major) = 29.22 min, tᵣ (minor) = 45.97 min, ee = 96%.
Ethyl (2S,3R,4S,4aR,8aS)-4-(4-fluorophenyl)-8a-hydroxy-3-nitrooctahydro-2H-chromene-2-carboxylate (10aca). The title product was obtained from cyclohexanone 6a, trans-4-fluoro-β-nitrostyrene 7c and ethyl glyoxylate 8a employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. Yield 62% (228 mg, 0.62 mmol), white solid. 

\[ m_p = 179-181 \, ^\circ \text{C}. \quad [\alpha]_D^{25} = +57.03 \, (c \, 0.42, \text{chloroform}). \]

**FTIR (neat, cm\(^{-1}\))**
3483, 2937, 1747, 1548, 1225.

**\(^1\)H NMR (400 MHz, CDCl\(_3\))** \(\delta\) 7.13 – 7.06 (m, 2H, ArH), 7.02 (t, \(J = 8.6 \, \text{Hz}, 2\text{H}, \text{ArH}\)), 5.13 (d, \(J = 3.1 \, \text{Hz}, 1\text{H}, \text{C}^9\text{H}\)), 5.08 (dd, \(J = 4.8, 3.2 \, \text{Hz}, 1\text{H}, \text{C}^6\text{H}\)), 4.27 (dq, \(J = 10.7, 7.1 \, \text{Hz}, 1\text{H}, \text{CH}_2\text{CH}_3\)), 4.19 (dq, \(J = 10.8, 7.1 \, \text{Hz}, 1\text{H}, \text{CH}_2\text{CH}_3\)), 3.51 (dd, \(J = 12.5, 4.8 \, \text{Hz}, 1\text{H}, \text{C}^7\text{H}\)), 2.55 (tdd, \(J = 12.5, 3.3, 1.5 \, \text{Hz}, 1\text{H}, \text{C}^8\text{H}\)), 2.12 (s, 1H, OH), 2.05 – 1.90 (m, 2H, CH\(_2\)), 1.77 (ddt, \(J = 11.1, 4.5, 2.2 \, \text{Hz}, 1\text{H}, \text{CH}_2\)), 1.72 – 1.65 (m, 1H, CH\(_2\)), 1.59 (d, \(J = 6.7 \, \text{Hz}, 1\text{H}, \text{CH}_2\)), 1.41 – 1.28 (m, 2H, CH\(_2\)), 1.23 (t, \(J = 7.1 \, \text{Hz}, 3\text{H}, \text{CH}_2\text{CH}_3\)), 1.09 (qd, \(J = 14.1, 13.3, 4.2 \, \text{Hz}, 1\text{H}, \text{CH}_2\)).

**\(^{13}\)C{H} NMR (126 MHz, CDCl\(_3\))** \(\delta\) 167.6, 162.5 (d, \(^1J_{C,F} = 246.9 \, \text{Hz}\)), 131.9 (d, \(^4J_{C,F} = 3.3 \, \text{Hz}\)), 129.9, 116.1 (d, \(^2J_{C,F} = 21.5 \, \text{Hz}\)), 98.1, 86.9, 69.3, 62.4, 43.4, 39.2, 38.5, 26.2, 25.6, 23.1, 14.1. **\(^19\)F NMR (376 MHz, CDCl\(_3\))** \(\delta\) -113.91.

**HRMS (ESI) m/z [M+K]+** Calcd for C\(_{18}\)H\(_{22}\)FNO\(_6\)K 406.1062; Found 406.1058.

**HPLC (Chiralpak IA, Hexane:iPrOH = 95:5, flow rate 1 mL/min, \(\lambda = 210 \, \text{nm}\))**, \(t_R\) (major) = 24.74 min, \(t_R\) (minor) = 51.81 min, ee = 99%.

| RT  | Height | Area   | % Area | RT  | Height | Area   | % Area |
|-----|--------|--------|--------|-----|--------|--------|--------|
| 1   | 24.738 | 863261 | 47.46  | 1   | 24.740 | 1075388| 100.0  |
| 2   | 51.806 | 540955 | 52.24  | 2   | 3865772| 100.0  |        |
Ethyl (2S,3R,4S,4aR,8aS)-8a-hydroxy-3-nitro-4-(p-tolyl)octahydro-2H-chromene-2-carboxylate (10ada). The title product was obtained from cyclohexanone 6a, trans-4-methyl-β-nitrostyrene 7d and ethyl glyoxylate 8a employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. Yield 47% (171 mg, 0.47 mmol), white solid. m_p = 174-177 °C. [α]_D^{25} = +57.69 (c 0.5, chloroform). FTIR (neat, cm⁻¹) 3475, 1750, 1549, 1372. \(^1\)H NMR (500 MHz, CDCl₃) δ 7.13 (d, J = 7.7 Hz, 2H, ArH), 7.01 (d, J = 7.6 Hz, 2H, ArH), 5.13 (d, J = 3.0 Hz, 1H, C₉H), 5.09 (s, 1H, C₈H), 4.27 (dd, J = 10.8, 7.0 Hz, 1H, C₇H₂CH₃), 4.17 (dd, J = 11.0, 6.9 Hz, 1H, C₇H₂CH₃), 3.48 (dd, J = 12.5, 4.9 Hz, 1H, C⁷H), 2.57 (td, J = 12.5, 3.4 Hz, 1H, C₆H), 2.32 (s, 3H, CH₃), 2.16 (s, 1H, OH), 2.00 (td, J = 13.7, 4.3 Hz, 1H, C₂H), 1.93 (d, J = 14.1 Hz, 1H, C₂H), 1.77 (d, J = 13.7 Hz, 1H, C₂H), 1.71 – 1.53 (m, 2H, C₂H), 1.44 – 1.26 (m, 2H, C₂H), 1.23 (t, J = 7.1 Hz, 3H, CH₂C₂H₃), 1.09 (qd, J = 12.8, 3.4 Hz, 1H, C₂H). \(^13\)C{H} NMR (126 MHz, CDCl₃) δ 167.7, 137.8, 133.1, 129.8, 128.1, 98.2, 87.1, 69.4, 62.3, 43.7, 39.0, 38.6, 26.2, 25.6, 23.1, 21.2, 14.1. HRMS (ESI) m/z [M+H]^+ Calcd for C₁₉H₂₆NO₆ 364.1760; Found 364.1948. HPLC (Chiralpak IA, Hexane:iPrOH = 95:5, flow rate 1 mL/min, λ = 210 nm), t_R (major) = 18.53 min, t_R (minor) = 28.20 min, ee = 95%.

| RT  | Height | Area   | % Area | RT  | Height | Area   | % Area |
|-----|--------|--------|--------|-----|--------|--------|--------|
| 1   | 18.536 | 791336 | 41797044 | 54.69 | 1 | 18.092 | 2861341 | 24594501 | 97.63 |
| 2   | 28.203 | 439680 | 34632155 | 45.31 | 2 | 28.230 | 77664 | 5977755 | 2.37 |

Ethyl (2S,3R,4S,4aR,8aS)-8a-hydroxy-3-nitro-4-(4-(trifluoromethyl)phenyl)octahydro-2H-chromene-2-carboxylate (10aea). The title product was obtained from cyclohexanone 6a, trans-4-trifluoromethyl-β-nitrostyrene 7e and ethyl glyoxylate 8a employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. Yield 60% (250 mg, 0.60 mmol), white solid. m_p = 167-169 °C. [α]_D^{25} = +27.00
(c 0.80, chloroform). **FTIR** (neat, cm⁻¹) 3474, 2938, 1751, 1551, 1325. \(^1H\) NMR (400 MHz, CDCl₃) δ 7.60 (d,  J = 8.1 Hz, 2H, ArH), 7.31 – 7.21 (m, 2H, ArH), 5.15 (d,  J = 3.1 Hz, 1H, C⁶H), 5.11 (dd,  J = 4.8, 3.2 Hz, 1H, C⁵H), 4.28 (dq,  J = 10.8, 7.2 Hz, 1H, CH₂CH₃), 4.19 (dq,  J = 10.8, 7.1 Hz, 1H, CH₂CH₃), 3.60 (dd,  J = 12.5, 4.8 Hz, 1H, C⁷H), 2.61 (td,  J = 12.4, 3.1 Hz, 1H, C₆H), 2.18 (s, 1H, OH), 2.06 – 1.90 (m, 2H, CH₂), 1.83 – 1.73 (m, 1H, CH₂), 1.66 (ddt,  J = 31.0, 13.1, 4.2 Hz, 2H, CH₂), 1.11 (qd,  J = 13.3, 2.8 Hz, 1H, CH₂). \(^13C\)H NMR (126 MHz, CDCl₃) δ 167.5, 140.4, 130.5 (d, \(^2JC-F\) = 32.7 Hz), 128.8, 126.1 (q, \(^3JC-F\) = 3.7 Hz), 124.0 (d, \(^1JC-F\) = 272.2 Hz), 97.98, 86.50, 69.27, 62.46, 43.92, 38.99, 38.44, 26.17, 25.54, 23.04, 14.06. \(^19F\) NMR (376 MHz, CDCl₃) δ -62.69. HRMS (ESI) m/z [M+Na]\(^+\) Calcd for C₁₉H₂₂F₃NO₆Na 440.1297; Found 440.1287.

**HPLC** (Chiralpak IA, Hexane:iPrOH = 95:5, flow rate 1 mL/min, \(\lambda = 210\) nm), \(t_R\) (major) = 9.91 min, \(t_R\) (minor) = 22.49 min, ee = 98%.

| RT  | Height  | Area       | % Area | Area       | % Area |
|-----|---------|------------|--------|------------|--------|
| 1   | 9.913   | 1763203    | 52.88  | 98242087   |        |
| 2   | 22.488  | 1023519    | 47.12  | 87536948   |        |

**Ethyl (2S,3R,4S,4aR,8aS)-4-(3-bromophenyl)8a-hydroxy-3-nitrooctahydro-2H-chromene-2-carboxylate (10afa)**. The title product was obtained from cyclohexanone 6a, trans-3-bromo-β-nitrostyrene 7f and ethyl glyoxylate 8a employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. Yield 54% (231 mg, 0.54 mmol), yellow oil. \(\alpha\)_D\(^{25}\) = +41.57 (c 0.75, chloroform). **FTIR** (neat, cm⁻¹) 3469, 2938, 1750, 1549, 1339. \(^1H\) NMR (400 MHz, CDCl₃) δ 7.43 (dt,  J = 8.2, 1.2 Hz, 1H, ArH), 7.31 (d,  J = 1.9 Hz, 1H, ArH), 7.20 (t,  J = 7.9 Hz, 1H, ArH), 7.04 (d,  J = 7.8 Hz, 1H, ArH), 5.12 (d,  J = 3.1 Hz, 1H, C⁶H), 5.09 (dd,  J = 4.7, 3.2 Hz, 1H, C⁵H), 4.28 (dq,  J = 11.0, 7.1 Hz, 1H, CH₂CH₃), 4.19 (dq,  J = 10.8, 7.1 Hz, 1H, CH₂CH₃), 3.49 (dd,  J = 12.4, 4.7 Hz, 1H, C⁷H), 2.55 (td,  J = 12.4, 3.1 Hz, 1H, C⁶H), 2.05 – 1.86 (m, 2H, CH₂), 1.78 – 1.67 (m, 4H, CH₂, OH), 1.41 – 1.27 (m, 2H, CH₂), 1.24 (t,  J = 7.1 Hz, 3H, CH₃).
1.24 (t, J = 7.1 Hz, 3H, CH₂CH₃), 1.12 (td, J = 12.5, 3.4 Hz, 1H, CH₂) ¹³C{H} NMR (126 MHz, CDCl₃) δ 167.5, 138.6, 131.4, 130.7, 123.1, 98.0, 86.6, 69.3, 62.4, 43.8, 38.9, 38.5, 26.2, 25.6, 23.1, 14.1. HRMS (ESI) m/z [M+Na]+ Calcd for C₁₈H₂₂BrNO₆Na 452.0528; Found 452.0494. HPLC (Chiralpak IA, Hexane:PrOH = 95:5, flow rate 1 mL/min, λ = 210 nm), tᵣ (major) = 8.28 min, tᵣ (minor) = 10.27 min, ee = 99%.

| RT  | Height | Area  | % Area |
|-----|--------|-------|--------|
| 1   | 8.280  | 1569463 | 49.32  |
| 2   | 10.265 | 1464174 | 50.68  |

Ethyl (2S,3R,4R,4aR,8aS)-4-(furan-2-yl)-8a-hydroxy-3-nitrooctahydro-2H-chromene-2-carboxylate (10aga). The title product was obtained at 0 °C from cyclohexanone 6a, trans-2-(2-nitrovinyl)furan 7g and ethyl glyoxylate 8a employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. The product was obtained as an inseparable 96:4 mixture of diastereomers. Yield 73% (248 mg, 0.73 mmol), white solid. mᵣ = 173-175 °C. [α]ᵦ⁺²⁵ = +89.49 (c 0.85, chloroform). FTIR (neat, cm⁻¹) 3480, 2938, 1754, 1552, 1209. ¹H NMR (500 MHz, CDCl₃) δ 7.34 (dd, J = 1.8, 0.8 Hz, 1H, ArH), 6.31 (dd, J = 3.2, 1.9 Hz, 1H, ArH), 6.17 (d, J = 3.2 Hz, 1H, ArH), 5.19 (dd, J = 4.8, 3.1 Hz, 1H, C²H), 5.05 (d, J = 3.1 Hz, 1H, C³H), 4.31 – 4.23 (m, 1H, CH₂CH₃), 4.19 (dq, J = 10.7, 7.1 Hz, 1H, CH₂CH₃), 3.66 (dd, J = 12.5, 4.8 Hz, 1H, C⁶H), 2.48 (td, J = 12.4, 3.4 Hz, 1H, C⁶H), 2.24 (s, 1H, OH), 1.92 (t, J = 4.1 Hz, 2H, CH₂), 1.79 – 1.67 (m, 2H, CH₂), 1.66 – 1.53 (m, 1H, CH₂), 1.44 – 1.37 (m, 1H, CH₂), 1.35 – 1.27 (m, 1H, CH₂), 1.24 (t, J = 7.1 Hz, 3H, CH₂CH₃), 1.22 – 1.11 (m, 1H, CH₂).

¹³C{H} NMR (126 MHz, CDCl₃) δ 167.6, 150.3, 142.6, 110.5, 108.5, 97.8, 84.8, 68.9, 62.3, 39.2, 38.3, 26.3, 25.5, 23.0, 14.1. HRMS (ESI) m/z [M+H-H₂O]+ Calcd for C₁₆H₂₅NO₆ 322.1287; Found 322.1282. HPLC (Chiralpak IA, Hexane:PrOH = 95:5, flow rate 1 mL/min, λ = 210 nm), tᵣ (major) = 21.10 min, tᵣ (minor) = 26.41 min, ee = 95%.
Ethyl (2S,3R,4R,4aR,8aS)-8a-hydroxy-3-nitro-4-(thiophen-2-yl)octahydro-2H-chromene-2-carboxylate (10aha). The title product was obtained at 0 °C from cyclohexanone 6a, trans-2-(2-nitrovinyl)thiophene 7h and ethyl glyoxylate 8a employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. Yield 46% (164 mg, 0.46 mmol), white solid. m_p = 144-146 °C. [α]_D^{25} = +57.84 (c 0.75, chloroform). FTIR (neat, cm⁻¹) 3484, 2939, 1749, 1550, 856. ¹H NMR (400 MHz, CDCl₃) δ 7.22 (dd, J = 5.1, 1.1 Hz, 1H, ArH), 6.96 (dd, J = 5.2, 3.5 Hz, 1H, ArH), 6.84 (d, J = 3.5 Hz, 1H, ArH), 5.15 (m, 2H, C⁹H, C⁸H), 4.32 – 4.24 (m, 1H, CH₂CH₃), 4.19 (dt, J = 10.8, 7.1 Hz, 1H, CH₂CH₃), 3.78 (dd, J = 12.3, 4.5 Hz, 1H, C'H), 2.60 (td, J = 12.3, 3.4 Hz, 1H, C⁶H), 2.15 (s, 1H, OH), 2.04 – 1.94 (m, 1H, CH₂), 1.90 (dt, J = 14.0, 3.0 Hz, 1H, CH₂), 1.81 – 1.59 (m, 3H, CH₂), 1.55 – 1.45 (m, 1H, CH₂), 1.32 (dt, J = 13.0, 3.9 Hz, 1H, CH₂), 1.25 (t, J = 7.1 Hz, 3H, CH₃CH₂), 1.15 (td, J = 12.8, 3.5 Hz, 1H, CH₂). ¹³C{H} NMR (126 MHz, CDCl₃) δ 167.4, 138.6, 127.5, 126.0, 125.0, 98.1, 87.0, 69.3, 62.4, 40.9, 39.61, 38.4, 26.3, 25.6, 23.1, 14.1. HRMS (ESI) m/z [M+Na]^+ Calcd for C₁₆H₂₁NO₆SNa 378.0979; Found 378.0978. HPLC (Chiralpak IA, Hexane:iPrOH = 97:3, flow rate 1 mL/min, λ = 210 nm), t_R (major) = 18.25 min, t_R (minor) = 25.59 min, ee = 95%.
Ethyl (2S,3R,4S,4aR,8aS)-8a-hydroxy-3-nitro-4-((E)-1-phenylprop-1-en-2-yl)octahydro-2H-chromene-2-carboxylate (10aia). The title product was obtained at 0 °C from cyclohexanone 6a, ((1E,3E)-2-methyl-4-nitrobuta-1,3-dien-1-yl)benzene 7i and ethyl glyoxylate 8a employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. Yield 55% (214 mg, 0.55 mmol), white solid. m_p = 157-159 °C. [α]_D^25 = +54.56 (c 0.60, chloroform).

**FTIR** (neat, cm⁻¹) 3467, 2938, 1740, 1552, 1372. **¹H NMR** (400 MHz, CDCl₃) δ 7.36 (dd, J = 8.7, 6.7 Hz, 2H, ArH), 7.26 (dd, J = 7.9, 6.3 Hz, 3H, ArH), 6.35 (s, 1H, CH=C), 5.22 (dd, J = 4.9, 3.2 Hz, 1H, C₈H), 5.08 (d, J = 3.2 Hz, 1H, C₉H), 4.40 – 4.30 (dq, J = 10.8, 7.1 Hz, 1H, CH₂CH₃), 4.25 (dq, J = 10.8, 7.1 Hz, 1H, CH₂CH₃), 3.02 (dd, J = 12.3, 4.9 Hz, 1H, C₇H), 2.37 (td, J = 12.2, 2.9 Hz, 1H, C₈H), 2.18 (s, 1H, OH), 2.06 – 1.92 (m, 2H, CH₂), 1.88 (d, J = 1.3 Hz, 3H, CH₃C=CH), 1.85 – 1.76 (m, 3H, CH₂), 1.73 – 1.60 (m, 1H, CH₂), 1.38 (dq, J = 12.8, 5.3, 4.5 Hz, 1H, CH₂), 1.30 (d, J = 7.1 Hz, 3H, CH₂CH₃), 1.24 (dd, J = 13.0, 9.7 Hz, 1H, CH₂).

**¹³C{H} NMR** (126 MHz, CDCl₃) δ 167.8, 137.3, 132.8, 129.6, 129.1, 128.2, 126.9, 97.9, 84.8, 69.2, 62.4, 46.6, 38.6, 38.4, 26.1, 25.7, 23.1, 14.1. **HRMS** (ESI) m/z [M+H]^+ Calcd for C₂₁H₂₈NO₆ 390.1922; Found 390.1924. **HPLC** (Chiralpak IB, Hexane:PrOH = 95:5, flow rate 1 mL/min, λ = 210 nm), t_R (major) = 13.30 min, t_R (minor) = 16.24 min, ee = 99%.
Ethyl \((2S,3R,4S,4aR,9aS)-9a\text{-hydroxy-3-nitro-4-phenyldecahydrocyclohepta}[b]\text{pyran-2-carboxylate} \) \((10\text{baa})\). The title product was obtained from cycloheptanone \(6b\), \(trans\)-\(\beta\)-nitrostyrene \(7a\) and ethyl glyoxylate \(8a\) employing TFA as additive. Purified on 1:1 Diethyl ether:hexane mixture. The product was obtained as an inseparable 92:8 mixture of diastereomers. Yield: 53\% (193 mg, 0.53 mmol), colorless oil. 

\(\left[\alpha\right]_{D}^{25} = +42.64 \) \((c 0.25, \text{chloroform})\). \textbf{FTIR} \((\text{neat, cm}^{-1})\) 3404, 2982, 1740, 1552, 1370. 

\textbf{\(^1\text{H NMR}\) } \((400 \text{ MHz, CDCl}_3)\) \(\delta 7.38 \) \((dd, J = 8.1, 6.5 \text{ Hz, } 2\text{H, ArH})\), \(7.34 – 7.25 \) \((m, 3\text{H, ArH})\), \(5.25 \) \((dd, J = 11.1, 2.3 \text{ Hz, } 1\text{H, C}^9\text{H})\), \(4.35 – 4.16 \) \((m, 2\text{H, CH}_2\text{CH}_3)\), \(4.16 – 4.08 \) \((m, 1\text{H, C}^8\text{H})\), \(3.94 – 3.86 \) \((m, 1\text{H, C}^7\text{H})\), \(3.24 – 3.14 \) \((m, 1\text{H, OH})\), \(2.85 \) \((ddd, J = 11.6, 8.1, 3.8 \text{ Hz, } 1\text{H, C}^6\text{H})\), \(2.38 – 2.21 \) \((m, 1\text{H, CH}_2)\), \(1.88 – 1.73 \) \((m, 3\text{H, CH}_2)\), \(1.66 \) \((d, J = 53.8 \text{ Hz, } 3\text{H, CH}_2)\), \(1.43 \) \((s, 1\text{H, CH}_2)\), \(1.28 \) \((d, J = 7.1 \text{ Hz, } 3\text{H, CH}_2\text{CH}_3)\), \(1.25 \) \((d, J = 4.0 \text{ Hz, } 1\text{H, CH}_2)\), \(1.22 – 1.06 \) \((m, 1\text{H, CH}_2)\).  

\textbf{\(^{13}\text{C(\text{H}) NMR}\) } \((101 \text{ MHz, CDCl}_3)\) \(\delta 170.8, 136.5, 129.2, 129.1, 128.1, 90.1, 69.8, 62.8, 55.2, 46.8, 42.8, 29.5, 28.3, 28.1, 24.8, 14.0\). \textbf{HRMS} \((\text{ESI})\) m/z Calcd for \([\text{M+H}]^+\) \(C_{19}H_{26}NO_6\) 364.1760; Found 364.1761. \textbf{HPLC} \((\text{Chiralpak IC, Hexane:PrOH = 90:10, flow rate 1 mL/min, } \lambda = 214 \text{ nm})\), \(t_R \) \((\text{minor}) = 17.35 \text{ min, } t_R \) \((\text{major}) = 19.42 \text{ min, } ee = 90\%\).
Ethyl (2S,3R,4S,4aR,8aS)-8a-hydroxy-3-nitro-4-phenylhexahydropy-2H,5H-spiro[chromene-6,2’-[1,3]dioxolane]-2-carboxylate (10caa). The title product was obtained from 1,4-cyclohexanedione monoethylene acetal 6c, trans-β-nitrostyrene 7a and ethyl glyoxylate 8a employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. Yield: 62% (253 mg, 0.62 mmol), colorless oil. \( \alpha \) = +13.31 (c 0.7, chloroform). FTIR (neat, cm\(^{-1}\)) 3445, 2963, 1734, 1550, 1370. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.39 – 7.26 (m, 3H, ArH), 7.18 – 7.12 (m, 2H, ArH), 5.13 (d, \( J = 3.1 \) Hz, 1H, C\(^9\)H), 5.10 (dd, \( J = 4.8, 3.2 \) Hz, 1H, C\(^9\)H), 4.28 (dd, \( J = 10.8, 7.1 \) Hz, 1H, CH\(_2\)CH\(_3\)), 4.26 – 4.07 (m, 1H, CH\(_2\)CH\(_3\)), 3.98 – 3.92 (m, 1H, CH\(_2\)O), 3.86 (ddd, \( J = 12.5, 6.9, 5.5 \) Hz, 2H, CH\(_2\)O), 3.82 – 3.74 (m, 1H, CH\(_2\)O), 3.53 (dd, \( J = 12.7, 4.8 \) Hz, 1H, C\(^7\)H), 3.00 (ddd, \( J = 12.7, 9.9, 6.5 \) Hz, 1H, CH\(_2\)), 2.35 (td, \( J = 15.1, 4.8 \) Hz, 1H, ArH), 2.21 (s, 1H, OH), 2.01 – 1.87 (m, 2H, CH\(_2\)), 1.86 – 1.75 (m, 1H, CH\(_2\)), 1.45 (dd, \( J = 8.7, 1.8 \) Hz, 2H, CH\(_2\)), 1.23 (t, \( J = 7.1 \) Hz, 3H, CH\(_2\)CH\(_3\)). \(^{13}\)C{\( ^1\)H} NMR (126 MHz, CDCl\(_3\)) \( \delta \) 167.7, 136.0, 129.5, 128.6, 108.6, 97.7, 86.5, 69.9, 64.9, 64.7, 62.7, 43.9, 36.2, 35.9, 35.1, 32.3. HRMS (ESI) m/z [M+H-H\(_2\)O]+ Calcd for C\(_{20}\)H\(_{24}\)NO\(_7\) 390.1546; Found 390.1541. HPLC (Chiralpak IA, Hexane:PrOH = 95:5, flow rate 1 mL/min, \( \lambda = 210 \) nm), \( t_R \) (major) = 24.06 min, \( t_R \) (minor) = 39.51 min, ee = 88%.
The title product was obtained from cyclohexanone 6a, trans-\(\beta\)-nitrostyrene 7a and benzaldehyde 8b employing salicylic acid as additive and 1 equivalent of triethylamine. Purified on 1:3 EtOAc:Hexane mixture. Global yield 65%. Isolated yield 30% (107 mg, 0.30 mmol), white solid. 

\[ \text{mp} = 195-197 \, ^\circ \text{C}. \] \[ \left[ \alpha \right]_{D}^{25} = +26.45 \, (c 0.40, \text{chloroform}). \] \[ \text{FTIR (neat, cm}^{-1}) 3511, 2922, 1548, 1335. \] \[ ^{1} \text{H NMR (500 MHz, CDCl}_3) \delta 7.40 – 7.36 (m, 2H, ArH), 7.35 – 7.28 (m, 4H, ArH), 7.27 – 7.24 (m, 2H, ArH), 7.17 (dd, \( J = 7.0, 1.7 \, \text{Hz}, 2H, \text{ArH}), 5.66 \, (d, \( J = 3.1 \, \text{Hz}, 1H, \text{C}^{6}H)), 4.95 \, (dd, \( J = 4.6, 3.2 \, \text{Hz}, 1H, \text{C}^{8}H)), 3.59 \, (dd, \( J = 12.5, 4.5 \, \text{Hz}, 1H, \text{C}^{7}H)), 2.97 \, (ddt, \( J = 14.7, 11.4, 1.6 \, \text{Hz}, 1H, \text{C}^{6}H)), 2.07 \, (td, \( J = 13.7, 4.5 \, \text{Hz}, 1H, \text{CH}_2)), 1.92 \, (bs, 1H, \text{OH}), 1.87 \, (ddt, \( J = 13.7, 4.0, 2.1 \, \text{Hz}, 1H, \text{CH}_2)), 1.84 – 1.76 \, (m, 1H, \text{CH}_2)), 1.76 – 1.64 \, (m, 1H, \text{CH}_2)), 1.48 – 1.35 \, (m, 2H, \text{CH}_2)), 1.26 \, (m, 1H, \text{CH}_2)), 1.19 \, (td, \( J = 12.6, 3.1 \, \text{Hz}, 1H, \text{CH}_2)). \] \[ ^{13} \text{C} \{ \text{H} \} \text{NMR (126 MHz, CDCl}_3) \delta 136.9, 136.7, 129.2, 128.7, 128.5, 127.9, 126.0, 97.9, 91.9, 71.1, 44.4, 38.9, 38.7, 26.1, 25.9, 23.2. \] \[ \text{HRMS (ESI) m/z [M+H-H}_2\text{O}]^+ \text{ Calcd for C}_{21}\text{H}_{22}\text{NO}_3 336.1592; \text{ Found 336.1589.} \] \[ \text{HPLC (Chiralpak IA, Hexane:PrOH = 95:5, flow rate 1 mL/min, } \lambda = 210 \, \text{nm), } t_R \text{ (major) } = 21.56 \, \text{min, } t_R \text{ (minor) } = 31.23 \, \text{min, } ee > 99\%. \]
The title product was obtained from cyclohexanone 6a, trans-β-nitrostyrene 7a and benzaldehyde 8b employing salicylic acid as additive and 1 equivalent of triethylamine. Purified on 1:3 EtOAc:Hexane mixture. Global yield 65%. Isolated yield 35% (123 mg, 0.35 mmol), white solid. \( m_p = 223-225 \, ^\circ\text{C}. \) \( [\alpha]_{D}^{25} = +31.48 \) (c 0.25, chloroform). FTIR (neat, cm\(^{-1}\)) 3552, 2928, 1544, 1123. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.42 – 7.22 (m, 10H), 5.55 (d, \( J = 10.0 \) Hz, 1H, C\(^9\)H), 4.77 (t, \( J = 10.6 \) Hz, 1H, C\(^8\)H), 3.72 (t, \( J = 11.6 \) Hz, 1H, C\(^7\)H), 2.17 (s, 1H, OH)2.05 (s, 1H, CH\(_2\)), 1.88 (d, \( J = 11.8 \) Hz, 1H, C\(^6\)H), 1.84 – 1.74 (m, 2H, CH\(_2\)), 1.69 (d, \( J = 15.3 \) Hz, 2H, CH\(_2\)), 1.38 – 1.22 (m, 1H, CH\(_2\)), 1.19 (d, \( J = 5.4 \) Hz, 2H, CH\(_2\)). \(^{13}\)C{H} NMR (126 MHz, CDCl\(_3\)) \( \delta \) 136.9, 136.7, 129.2, 128.7, 128.5, 127.9, 126.0, 97.9, 91.9, 71.1, 44.4, 38.9, 38.7, 26.1, 25.9, 23.2. HRMS (ESI) m/z [M+H-H\(_2\)O]+ Calcd for C\(_{21}\)H\(_{22}\)NO\(_3\) 336.1592; Found 336.1591. HPLC (Chiralpak IA, Hexane:iPrOH = 95:5, flow rate 1 mL/min, \( \lambda = 210 \) nm), \( t_R \) (major) = 9.17 min, \( t_R \) (minor) = 11.68 min, ee = 96%.
(2R,3R,4S,4aR,8aS)-2-(4-fluorophenyl)-3-nitro-4-phenyloctahydro-8aH-chromen-8-ol **(10aac)**. The title product was obtained from cyclohexanone **6a**, trans-β-nitrostyrene **7a** and 4-fluorobenzaldehyde **8c** employing salicylic acid as additive and 1 equivalent of triethylamine. Purified on 1:3 EtOAc:Hexane mixture. Global yield 81%. Isolated yield 54% (201 mg, 0.54 mmol), white solid. $m_p = 198-200 \, ^\circ\mathrm{C}$. $[\alpha]_D^{25} = +12.05$ (c 0.60, chloroform). **FTIR** (neat, cm$^{-1}$) 3510, 2950, 1551, 1118. **$^1H$ NMR** (400 MHz, CDCl$_3$) $\delta$ 7.39 – 7.22 (m, 5H, ArH), 7.21 – 7.11 (m, 2H, ArH), 7.01 (t, $J = 8.7 \, Hz$, 2H, ArH), 5.64 (d, $J = 3.2 \, Hz$, 1H, C$_9$H), 4.91 (t, $J = 3.9 \, Hz$, 1H, C$_8$H), 3.57 (dd, $J = 12.5$, 4.5 Hz, 1H, C$_7$H), 3.04 – 2.89 (m, 1H, C$_6$H), 2.05 (td, $J = 13.6$, 4.4 Hz, 1H, CH$_2$), 1.89 (d, $J = 1.5 \, Hz$, 1H, CH$_2$), 1.88 – 1.77 (m, 1H, CH$_2$), 1.77 – 1.60 (m, 2H, CH$_2$), 1.41 (td, $J = 13.4$, 12.5, 3.8 Hz, 2H, CH$_2$), 1.28 – 1.10 (m, 1H, CH$_2$). **$^{13}C{\{H\}}$ NMR** (126 MHz, CDCl$_3$) $\delta$ 162.7 (d, $^1J_{CF} = 246.8 \, Hz$), 136.7, 132.5 (d, $^4J_{CF} = 3.3 \, Hz$), 129.2, 128.0, 127.8 (d, $^3J_{CF} = 8.3 \, Hz$), 115.7 (d, $^2J_{CF} = 21.6 \, Hz$), 97.9, 92.0, 70.5, 44.4, 38.9, 38.6, 26.1, 25.8, 23.2. **$^{19}F$ NMR** (376 MHz, CDCl$_3$) $\delta$ -113.56. **HMRS** (ESI) m/z [M+H$_2$O]$^+$ Calcd for C$_{21}$H$_{21}$FNO$_3$ 354.1505; Found 354.1495. **HPLC** (Chiralpak IA, Hexane:PrOH = 95:5, flow rate 1 mL/min, $\lambda = 210 \, nm$), $t_R$ (minor) = 18.21 min, $t_R$ (major) = 37.22 min, ee = >99%.
(2R,3S,4S,4aR,8aS)-2-(4-fluorophenyl)-3-nitro-4-phenylloctahydro-8aH-chromen-8a-ol (10aac'). The title product was obtained from cyclohexanone 6a, trans-β-nitrostyrene 7a and 4-fluorobenzaldehyde 8c employing salicylic acid as additive and 1 equivalent of triethylamine. Purified on 1:3 EtOAc:Hexane mixture. Global yield 81%. Isolate yield 27% (100 mg, 0.27 mmol), white solid. m_p = 206-209 °C. [α]_D^25 = +61.88 (c 0.60, chloroform). FTIR (neat, cm⁻¹) 3484, 2936, 1547, 1115. ¹H NMR (400 MHz, CDCl₃) δ 7.36 (dd, J = 8.5, 5.3 Hz, 2H, ArH), 7.31 – 7.16 (m, 5H, ArH), 7.04 (t, J = 8.6 Hz, 2H, ArH), 5.54 (d, J = 9.9 Hz, 1H, C⁹H), 4.72 (t, J = 10.6 Hz, 1H, C⁸H), 3.71 (t, J = 11.6 Hz, 1H, C⁷H), 2.10 (s, 1H, OH), 1.88 (td, J = 11.8, 3.3 Hz, 1H, C⁶H), 1.77 – 1.55 (m, 4H, CH₂), 1.29 – 1.11 (m, 4H, CH₂). ¹³C{H} NMR (126 MHz, CDCl₃) δ 163.2 (d, J_CF = 247.9 Hz), 136.8, 132.7 (d, J_CF = 3.3 Hz), 129.1 (d, J_CF = 8.3 Hz), 128.1, 115.9 (d, J_CF = 21.7 Hz), 97.5, 95.1, 73.2, 47.1, 46.9, 38.8, 26.2, 25.7, 23.0. ¹⁹F NMR (376 MHz, CDCl₃) δ -112.35. HRMS (ESI) m/z [M+H]+ Calcd for C₂₁H₂₃FNO₄ 372.1721; Found 372.1720. HPLC (Chiralpak IA, Hexane:PrOH = 95:5, flow rate 1 mL/min, λ = 210 nm), t_R (minor) = 28.52 min, t_R (major) = 36.43 min, ee = 95%.
(2S,3S,4S,4aR,8aS)-2-(furan-2-yl)-3-nitro-4-phenyloctahydro-8aH-chromen-8a-ol (10aad'). The title product was obtained from cyclohexanone 6a, trans-β-nitrostyrene 7a and furfural 8d employing salicylic acid as additive. When one equivalent of Et₃N was used an inseparable 50:50 mixture of 10aad:10aad' isomers was obtained. Global yield 65% (223 mg, 0.65 mmol). ¹H NMR (400 MHz, CDCl₃) δ 7.70 (s, 2H, ArH), 7.52 – 7.00 (m, 10H, ArH), 6.41 (d, J = 3.3 Hz, 1H, ArH), 6.35 (d, J = 3.3 Hz, 1H, ArH), 6.32 (t, J = 2.5 Hz, 1H, ArH), 5.71 (d, J = 3.0 Hz, 1H, 10aad), 5.65 (d, J = 10.3 Hz, 1H, 10aad'), 5.11 (t, J = 10.8 Hz, 1H, 10aad'), 4.98 (t, J = 3.8 Hz, 1H, 10aad), 3.66 (t, J = 11.7 Hz, 1H, 10aad'), 3.52 (dd, J = 12.5, 4.4 Hz, 1H, 10aad), 2.98 – 2.87 (m, 1H, 10aad), 2.08 – 1.96 (m, 1H, 10aad), 1.93 – 1.81 (m, 2H, 10aad and 10aad'), 1.77 (m, 2H, 10aad and 10aad'), 1.66 (m, 4H, 10aad and 10aad'), 1.39 (m, 2H, 10aad and 10aad'), 1.15 (m, 8H, 10aad and 10aad'). The reaction performed at 1 mmol scale with 1 eq. of DBU allowed to obtain 10aad' with complete conversion. Purified on 1:2 EtOAc:Hexane mixture. Yield 68% (230 mg, 0. 68 mmol), white solid. m_p = 252-254 °C. [α]_D^25 = +5.66 (c 0.60, chloroform). FTIR (neat, cm⁻¹) 3539, 2935, 1546, 1124. ¹H NMR (500 MHz, CDCl₃) δ 7.44 (d, J = 1.7 Hz, 1H, ArH), 7.26 (s, 5H, ArH), 6.41 (d, J = 3.3 Hz, 1H, ArH), 6.32 (dd, J = 3.3, 1.9 Hz, 1H, ArH), 5.65 (d, J = 10.2 Hz, 1H, C³H), 5.11 (dd, J = 11.4, 10.2 Hz, 1H, C³H), 3.66 (t, J = 11.6 Hz, 1H, C³H), 2.15 (s, 1H, OH), 1.89 (tdd, J = 12.0, 3.7, 1.4 Hz, 1H, C³H), 1.83 – 1.75 (m, 2H, CH₂), 1.75 – 1.67 (m, 1H, CH₂), 1.67 – 1.60 (m, 1H, CH₂), 1.32 – 1.11 (m, 4H, CH₂). ¹³C{H} NMR (126 MHz, CDCl₃) δ 149.2, 143.9, 136.9, 128.1, 110.5, 110.4, 97.6, 91.3, 67.1, 46.8, 46.7, 38.6, 26.2, 25.6, 23.0. HPLC (Chiralpak IA, Hexane:iPrOH = 95:5, flow rate 1 mL/min,
$\lambda = 210$ nm), $t_R$ (10aad' minor) = 18.00 min, $t_R$ (10aad major) = 36.46 min, $t_R$ (10aad minor) = 44.74 min, $t_R$ (10aad' major) = 79.02 min. ee 10aad = 98%. ee 10aad' = 98%

10aad

| RT   | Height | Area  | % Area |
|------|--------|-------|--------|
| 1    | 18.000 | 692107| 82178228 | 35.51  |
| 2    | 36.456 | 224401| 36263819 | 15.58  |
| 3    | 44.743 | 202476| 35966472 | 15.45  |
| 4    | 79.042 | 267732| 78351878 | 33.66  |

10aad'

| RT   | Height | Area  | % Area |
|------|--------|-------|--------|
| 1    | 18.000 | 692107| 82178228 | 35.51  |
| 2    | 36.456 | 224401| 36263819 | 15.58  |
| 3    | 44.743 | 202476| 35966472 | 15.45  |
| 4    | 79.042 | 267732| 78351878 | 33.66  |

| RT   | Height | Area  | % Area |
|------|--------|-------|--------|
| 1    | 19.301 | 19103 | 2017127 | 0.86   |
| 2    | 37.885 | 1548286| 267427094| 99.19  |
| 3    | 46.633 | 19736 | 2173050 | 0.81   |
| 4    | 82.577 | 617310| 232611786| 99.14  |
(2R,3R,4S,4aR,8aS)-3-nitro-4-phenyl-2-((E)-styryloctahydro-8aH-chromen-8a-ol (10aae). The title product was obtained from cyclohexanone 6a, trans-β-nitrostyrene 7a and cinnamaldehyde 8e employing salicylic acid as additive. Purified on 1:4 EtOAc:Hexane mixture. Global yield 58% (220 mg, 0.58 mmol), white solid. \( m_p = 198-200^\circ C \). \([\alpha]_D^{25} = +58.20 \) (c 0.10, chloroform). FTIR (neat, cm\(^{-1}\)) 3499, 2922, 1713, 1546. 1\(^{H}\) NMR (500 MHz, CDCl\(_3\)) \( \delta \) 9.74 (d, \( J = 3.2 \) Hz, 1H, CH=CHPh), 7.33 – 7.22 (m, 8H, ArH), 7.22 – 7.14 (m, 2H, ArH), 4.93 (t, \( J = 4.5 \) Hz, 1H, C\(^6\)H), 4.10 (dd, \( J = 12.6, 4.5 \) Hz, 1H, C\(^8\)H), 3.98 (dd, \( J = 12.7, 3.3 \) Hz, 1H, CH=CHPh), 3.46 (dd, \( J = 12.2, 4.5 \) Hz, 1H, C\(^7\)H), 2.65 (td, \( J = 12.2, 3.3 \) Hz, 1H, C\(^8\)H), 2.39 (s, 1H, OH), 1.89 (d, \( J = 13.6 \) Hz, 1H, CH\(_2\)), 1.76 (td, \( J = 13.5, 4.3 \) Hz, 1H, CH\(_2\)), 1.68 (d, \( J = 13.0 \) Hz, 2H, CH\(_2\)), 1.39 – 1.23 (m, 3H, CH\(_2\)), 1.21 – 1.10 (m, 1H, CH\(_2\)). \(^{13}\)C{H} NMR (126 MHz, CDCl\(_3\)) \( \delta \) 206.9, 137.5, 136.0, 129.4, 129.2, 128.5, 128.2, 127.9, 94.9, 73.1, 54.9, 46.8, 42.9, 40.3, 37.5, 25.6, 25.1, 21.2. HRMS (ESI) m/z [M+H]\(^+\) Calcd for C\(_{23}\)H\(_{26}\)NO\(_4\) 380.1862; Found 380.1827. HPLC (Chiralpak IA, Hexane:iPrOH = 95:5, flow rate 1 mL/min, \( \lambda = 210 \) nm), \( t_R \) (minor) = 36.31 min, \( t_R \) (major) = 53.53 min, ee = >99%.  

| RT  | Height | Area  | % Area | RT  | Height | Area  | % Area |
|-----|--------|-------|--------|-----|--------|-------|--------|
| 1   | 36.314 | 122720| 3382833 | 1   |         |       |        |
| 2   | 53.522 | 99835 | 32558850| 2   | 53.928 | 447019| 159851852 | 100.0 |

(2S,3R,4S,4aR,8aS)-2-((R)-2,2-dimethyl-1,3-dioxolan-4-yl)-3-nitro-4-phenyl-octahydro-8aH-chromen-8a-ol (10aaf). The title product was obtained from cyclohexanone 6a, trans-β-nitrostyrene 7a and (R)-2,2-dimethyl-1,3-dioxolane-4-carbaldehyde 8f employing salicylic acid as additive. Purified on 1:3 EtOAc:Hexane mixture. Yield 64% (242 mg, 0.64 mmol), colorless oil. \([\alpha]_D^{25} = +34.32 \) (c 0.53, chloroform). FTIR (neat, cm\(^{-1}\)) 3434, 2986, 1546. 1\(^{H}\) NMR (400
MHz, CDCl$_3$) $\delta$ 7.29 (dt, $J$ = 13.3, 7.0 Hz, 3H, ArH), 7.17 – 7.09 (m, 2H, ArH), 4.94 (dd, $J$ = 4.7, 2.8 Hz, 1H, C$_8^\text{H}$), 4.29 (dd, $J$ = 8.9, 2.8 Hz, 1H, C$_6^\text{H}$), 4.13 – 4.05 (m, 1H, CHO), 4.00 – 3.92 (m, 2H, CH$_2$O), 3.40 (dd, $J$ = 12.4, 4.8 Hz, 1H, C$_7^\text{H}$), 2.73 (d, $J$ = 3.2 Hz, 1H, C$_6^\text{H}$), 2.27 (s, 1H, OH), 1.89 – 1.78 (m, 1H, CH$_2$), 1.78 – 1.52 (m, 4H, CH$_2$), 1.44 (s, 3H, CH$_3$), 1.37 (dd, $J$ = 12.1, 6.5 Hz, 2H, CH$_2$), 1.28 (s, 3H, CH$_3$), 1.22 – 0.97 (m, 1H, CH$_2$). $^{13}\text{C}^\text{H}$ NMR (126 MHz, CDCl$_3$) $\delta$ 136.8, 129.1, 127.9, 110.2, 97.5, 87.5, 74.2, 70.6, 67.5, 43.9, 39.1, 38.8, 27.1, 26.2, 25.8, 25.1, 23.2. HRMS (ESI) m/z [M+H-H$_2$O]$^+$ Calcd for C$_{20}$H$_{26}$NO$_5$ 360.1801; Found 360.1802.

(2S,3R,4S,4aR,8aS)-2-((R)-2,2-dimethyl-1,3-dioxolan-4-yl)-3-nitro-4-phenylhexahydro-2H,8aH-spiro[chromene-6,2’-[1,3]dioxolan]-8a-ol (10caf). The title product was obtained from 1,4-cyclohexanedione monoethylene acetal 6c, trans-$\beta$-nitrostyrene 7a and (R)-2,2-dimethyl-1,3-dioxolane-4-carbaldehyde 8f employing salicylic acid as additive. Purified on 1:2 EtOAc:Hexane mixture. Yield 52 % (227 mg, 0.52 mmol), colorless oil. $[\alpha]_{D}^{25} = +22.62$ (c 0.33, chloroform). FTIR (neat, cm$^{-1}$) 3393, 2960, 1546.

$^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.36 – 7.30 (m, 2H, ArH), 7.30 – 7.26 (m, 1H, ArH), 7.15 (dd, $J$ = 7.1, 1.7 Hz, 2H, ArH), 4.93 (dd, $J$ = 4.7, 2.8 Hz, 1H, C$_8^\text{H}$), 4.29 (dd, $J$ = 8.8, 2.8 Hz, 1H, C$_6^\text{H}$), 4.09 (td, $J$ = 7.3, 2.6 Hz, 1H, CHO), 3.99 – 3.97 (m, 1H, CH$_2$O), 3.96 – 3.94 (m, 1H, CH$_2$O), 3.91 – 3.83 (m, 2H, CH$_2$O), 3.83 – 3.77 (m, 1H, CH$_2$O), 3.42 (dd, $J$ = 12.7, 4.6 Hz, 1H, C$_7^\text{H}$), 3.16 – 3.08 (m, 1H, CH$_2$O), 2.18 (td, $J$ = 13.7, 4.4 Hz, 1H, C$_6^\text{H}$), 2.13 – 2.10 (bs, 1H, OH), 1.94 (td, $J$ = 13.4, 4.5 Hz, 1H, CH$_2$), 1.82 – 1.71 (m, 2H, CH$_2$), 1.45 (d, $J$ = 8.7 Hz, 2H, CH$_2$), 1.43 (s, 3H, CH$_3$), 1.29 (s, 3H, CH$_3$), 1.25 (s, 1H, CH$_2$). $^{13}$C$^\text{H}$ NMR (126 MHz, CDCl$_3$) $\delta$ 136.3, 129.2, 128.1, 110.3, 108.5, 96.7, 86.1, 74.2, 70.9, 67.5, 64.6, 64.4, 43.5, 36.1, 35.6, 34.7, 32.2, 27.1, 25.1. HRMS (ESI) m/z [M+H-H$_2$O]$^+$ Calcd for C$_{22}$H$_{28}$NO$_7$ 418.1859; Found 418.1857.

\begin{figure}[h]
\centering
\includegraphics[width=0.7\textwidth]{figure.png}
\caption{Structure of the title compound.}
\end{figure}
NMR spectra

Compound NO$_2$-X$_L$-Gly-OMe 14

$^1$H NMR (500 MHz, CDCl$_3$) of 14
$^{13}$C{H} NMR (101 MHz, CDCl$_3$) of 14

COSY (CDCl$_3$) of 14
**Compound 10aaa**

$^1$H NMR (400 MHz, CDCl$_3$) of 10aaa

![NMR spectrum of 10aaa](image)

$^{13}$C{H} NMR (101 MHz, CDCl$_3$) of 10aaa

![NMR spectrum of 10aaa](image)
COSY (CDCl₃) of 10aaa

HSQC (CDCl₃) of 10aaa
Compound 10aaa’

$^1$H NMR (400 MHz, CDCl$_3$) of 10aaa’

$^{13}$C{H} NMR (101 MHz, CDCl$_3$) of 10aaa’
COSY (CDCl₃) of 10aaa'

HSQC (CDCl₃) of 10aaa'
**Compound 10aba**

**$^1$H NMR (400 MHz, CDCl$_3$) of 10aba**

![1H NMR spectrum of 10aba](image)

**$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aba**

![$^{13}$C{H} NMR spectrum of 10aba](image)
Compound 10aca

$^1$H NMR (400 MHz, CDCl$_3$) of 10aca

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aca
$^{19}$F NMR (376 MHz, CDCl$_3$) of 10aca
Compound 10ada

$^1$H NMR (500 MHz, CDCl$_3$) of 10ada

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10ada
Compound 10aea

$^1$H NMR (400 MHz, CDCl$_3$) of 10aea

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aea
$^{19}$F NMR (376 MHz, CDCl$_3$) of 10aea
Compound 10afa

$^1$H NMR (400 MHz, CDCl$_3$) of 10afa

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10afa
**Compound 10aga**

\(^1\)H NMR (400 MHz, CDCl\(_3\)) of 10aga

\(\begin{array}{c}
\text{OH} \\
\text{CO}_2\text{Et} \\
\text{NO}_2
\end{array}\)

\(^{13}\)C{H} NMR (126 MHz, CDCl\(_3\)) of 10aga

\(\begin{array}{c}
\text{OH} \\
\text{CO}_2\text{Et} \\
\text{NO}_2
\end{array}\)
Compound 10aha

$^1\text{H NMR (400 MHz, CDCl}_3\text{) of 10aha}$

$^{13}\text{C}{^1}\text{H} \text{NMR (126 MHz, CDCl}_3\text{) of 10aha}$
Compound 10aia

$^1$H NMR (400 MHz, CDCl$_3$) of 10aia

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aia
Compound 10baa

$^1$H NMR (400 MHz, CDCl$_3$) of 10baa

$^{13}$C$\{^1$H$\}$ NMR (101 MHz, CDCl$_3$) of 10baa
Compound 10caa

$^1$H NMR (400 MHz, CDCl$_3$) of 10caa

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10caa
Compound 10aab

$^1$H NMR (500 MHz, CDCl$_3$) of 10aab

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aab
**Compound 10aab**

$^1$H NMR (400 MHz, CDCl$_3$) of 10aab

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aab
**Compound 10aac**

$^1$H NMR (400 MHz, CDCl$_3$) of 10aac

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aac
$^{19}$F NMR (376 MHz, CDCl$_3$) of 10aac
Compound 10aac'

$^1$H NMR (400 MHz, CDCl$_3$) of 10aac'

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aac'
$^{19F}$ NMR (376 MHz, CDCl$_3$) of 10aac'
Compound 10aad'

$^1$H NMR (500 MHz, CDCl$_3$) of 10aad'

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aad'
Compound 10aae

$^1$H NMR (500 MHz, CDCl$_3$) of 10aae

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aae
COSY (CDCl₃) of 10aae
Compound 10aaf

$^1$H NMR (400 MHz, CDCl$_3$) of 10aaf

$^{13}$C{H} NMR (126 MHz, CDCl$_3$) of 10aaf
Compound **10caf**

**¹H NMR (500 MHz, CDCl₃) of 10caf**

**¹⁳C{H} NMR (126 MHz, CDCl₃) of 10caf**
6  X-Ray diffraction structures

Compounds 10aaa and 10aaa' were recrystallized in a mixture of hexane and ethyl acetate. Crystal growth was performed by slow evaporation at room temperature of the solvent mixture.

6.1  X-Ray diffraction of 10aaa (CCDC 2090677)

Figure S1. ORTEP diagram with thermal ellipsoids in 50% probability for (2S, 3R, 4S, 4aR, 8aS)-10aaa.
CheckCIF/PLATON report for (2S, 3R, 4S, 4aR, 8aS)-10aaa.

| Bond precision: C-C = 0.0051 Å | Wavelength = 1.54184 |
| Cell: a=12.2192(6) b=5.5685(2) c=12.6363(6) | alpha=90 beta=90.969(4) gamma=90 |
| Temperature: 100 K | |
| Calculated Volume 859.68(7) | Reported Volume 859.68(7) |
| Space group P 21 | Hall group P 2yb |
| Moiety formula C18 H23 N O6 | Sum formula C18 H23 N O6 |
| Mr 349.37 | 349.37 |
| Dx, g cm⁻³ 1.350 | 1.350 |
| Z 2 | 2 |
| Mu (mm⁻¹) 0.845 | 0.844 |
| F000 372.0 | 372.0 |
| F000' 373.26 | |
| h,k,lmax 14,6,15 | 14,6,15 |
| Nref 3197 [1777] | 5436 |
| Tmin, Tmax 0.769, 0.888 | 0.501, 1.000 |
| Tmin' 0.582 | |

Correction method = # Reported T Limits: Tmin = 0.501 Tmax = 1.000
AbsCorr = MULTI-SCAN

Data completeness = 3.06/1.70 Theta(max) = 68.909

R(reflections) = 0.0438(5245) WR2(reflections) = 0.1231(5436)

S = 1.040 Npar = 229
6.2 X-Ray diffraction of 10aaa’ (CCDC 2090834)

Figure S2. ORTEP diagram with thermal ellipsoids in 50% probability for (2S, 3S, 4S, 4aR, 8aS)-10aaa’.
7 Computational studies

7.1 Michael-Henry-Hemiketalization Reaction

DFT calculations at the B3LYP-D3/6-31G(d) level of theory\(^\text{15}\) were performed to understand the Henry-hemiketalization steps, for which no mechanistic studies are available. In these studies, solvent effects were tackled with the Continuum Polarization Method\(^\text{16}\) (PCM, solvent=dichloromethane). All calculations were carried out with the Gaussian suite of programs.\(^\text{17}\) Formation of adduct 10aaa from cyclohexanone 6a, trans-β-nitrostyrene 7a and ethyl glyoxylate 8a in the presence of trimethylamine and salicylic acid was chosen as model
system. The reaction profile obtained for this specific transformation is gathered in Figure S3.

Once Michael intermediate 9aaa is generated, nitronate INT1 is formed as a consequence of the interaction between 9aa and trimethylamine, which is a suitable computational model of triethylamine. Nucleophilic addition of INT1 on the aldehyde moiety of 8a results in the formation of adduct INT2 with a calculated activation energy of ca. 7 kcal/mol. All our attempts of connecting this latter alcohol adduct with hemiacetal 10aaa met with no success. Instead, our calculations showed that participation of one equivalent of salicylic acid (SA) results in the activation of the nucleophilicity of the alcohol group of INT2, together with a slight enhancement of the electrophilicity of the ketone group (double HOMO-rising and LUMO-lowering activation). As a consequence, 10aaa is formed from INT2’ via TS2, with an activation energy similar to that found for the previous step via TS1 (Figure S1). Reorganization of the acid and base additives leads to hemiacetal 10aaa with a considerably exergonic thermodynamic balance from nitronate INT1. It is noteworthy that the C-O bond forming step takes place via an equatorial nucleophilic attack on the cyclohexanone moiety, which determines the (4aR,8aS) configuration of the trans-octahydro-2H-chromene moiety of 10aaa, in which all the substituents occupy equatorial positions, with the only exception of the nitro group.
Figure S3. Reaction profile (B3LYP-D3(PCM)/6-31G(d) level of theory) associated with formation of bicyclic hemiacetal 10aaa via nitronate intermediate INT4 derived from 9aaa. Trimethylamine has been used as a computational model of Et3N. SA stands for salicylic acid. Calculations were performed in dichloromethane solution. Numbers in parentheses are relative Gibbs energies (298 K) with respect to INT4 and are given in kcal/mol. Bond distances are given in Å.

7.2 Isomerization Reaction

This process is mediated by a suitable base such as DBU via nitronate INTaad shown in Figure S4. DFT calculations on these three local minima (B3LYP D3(PCM)/6 31G* level of theory using acetonitrile as solvent) showed that all-equatorial isomer 10aad' is ca. 4 kcal/mol more stable than 10aad, the nitronate intermediate INTaad laying only ca. 2 kcal/mol above 10aad. These results indicate that in the presence of DBU and a polar solvent such as acetonitrile the equilibrium is completely shifted towards the all-equatorial isomer, in nice agreement with our experimental findings.
Figure S4. Reaction profile (B3LYP-D3(PCM,solvent=acetonitrile)/6-31G(d) level of theory) associated with isomerization of bicyclic hemiacetal 10aad to all-equatorial diasteromer 10aad’ mediated by DBU. Numbers in parentheses are relative Gibbs energies (298 K), in kcal/mol. Optimized structures of both diasteremers and nitronate intermediate INTaad bound to DBU are also shown. Bond distances are given in Å.
Table S2.\textsuperscript{a} Energies (E, in a. u.), Zero-Point Vibrational Energies (ZPVE, in a.u.), Thermal Corrections\textsuperscript{b} for Gibbs Free Energies (TCGE, in a.u. at 298.15 K) and Number of Imaginary Frequencies\textsuperscript{c} (NIMAG, imaginary wave numbers in cm\textsuperscript{-1}) of the Stationary Points Reported in Figures 3 and 4

| Structure                  | E        | ZPVE    | TCGE    | NIMAG |
|----------------------------|----------|---------|---------|-------|
| INT1\textsuperscript{b}    | -998.59667 | 0.41517 | 0.36108 | 0     |
| Ethyl glyoxalate \textsuperscript{b} | -381.70803 | 0.09996 | 0.06717 | 0     |
| TS1 \textsuperscript{b}    | -1380.32681 | 0.52168 | 0.45880 | 1 (-46.74) |
| INT2 \textsuperscript{b}   | -1380.35850 | 0.52294 | 0.46133 | 0     |
| Salicylic acid (SA) \textsuperscript{b} | -496.06760 | 0.12042 | 0.08768 | 0     |
| INT2+SA \textsuperscript{b} | -1876.45725 | 0.64548 | 0.57238 | 0     |
| INT2' \textsuperscript{b}  | -1876.45392 | 0.64782 | 0.57274 | 0     |
| TS2 \textsuperscript{b}    | -1876.44136 | 0.64216 | 0.56743 | 1 (-707.28) |
| 10aaa+NMe3+SA \textsuperscript{b} | -1876.45874 | 0.64760 | 0.57388 | 0     |
| 10aaa+N(+)HMe3+SA(-)\textsuperscript{b} | -1876.47380 | 0.65054 | 0.58079 | 0     |
| 10aad+DBU\textsuperscript{c} | -1629.63603 | 0.62964 | 0.56430 | 0     |
| INTaad+DBU\textsuperscript{c} | -1629.62857 | 0.62873 | 0.56021 | 0     |
| 10aad'+DBU\textsuperscript{c} | -1629.64177 | 0.62957 | 0.56386 | 0     |

\textsuperscript{a}Calculations performed at the B3LYP-D3(PCM)/6-31(d) level of theory. \textsuperscript{b}Results obtained using dichloromethane as solvent. \textsuperscript{c}Results obtained using acetonitrile as solvent.
Cartesian coordinates of stationary points gathered in Figures 3 and 4

| Center Number | Atomic Number | Atomic Type | X         | Y         | Z         |
|---------------|---------------|-------------|-----------|-----------|-----------|
| 1             | 6             | 0           | -2.432174 | -0.095978 | 0.235440  |
| 2             | 6             | 0           | -4.140504 | -0.138668 | -1.659308 |
| 3             | 6             | 0           | -4.529494 | -1.579940 | 0.391841  |
| 4             | 6             | 0           | -4.719130 | -1.458622 | -1.134768 |
| 5             | 6             | 0           | -2.656370 | -0.003970 | -1.294811 |
| 6             | 1             | 0           | -4.700659 | 0.704184  | -1.229983 |
| 7             | 1             | 0           | -5.129351 | -0.802542 | 0.888132  |
| 8             | 1             | 0           | -4.212394 | -2.299506 | -1.627673 |
| 9             | 1             | 0           | -2.090497 | -0.796770 | -1.801743 |
| 10            | 1             | 0           | -2.995765 | 0.738194  | 0.681911  |
| 11            | 1             | 0           | -4.261802 | -0.079176 | -2.747394 |
| 12            | 1             | 0           | -4.856238 | -2.551860 | 0.772649  |
| 13            | 1             | 0           | -5.784360 | -1.542828 | -1.377936 |
| 14            | 1             | 0           | -2.252697 | 0.948803  | -1.653060 |
| 15            | 6             | 0           | -3.080429 | -1.363062 | 0.794675  |
| 16            | 8             | 0           | -2.483224 | -2.140478 | 1.522027  |
| 17            | 6             | 0           | -0.960193 | 0.060471  | 0.689337  |
| 18            | 6             | 0           | -0.449048 | 1.469961  | 0.385175  |
| 19            | 6             | 0           | 0.392439  | 4.102901  | -0.156090 |
| 20            | 6             | 0           | 0.293038  | 1.761336  | -0.765998 |
| 21            | 6             | 0           | -0.764947 | 2.517546  | 1.259790  |
| 22            | 6             | 0           | -0.351005 | 3.823702  | 0.993776  |
| 23            | 6             | 0           | 0.714131  | 3.065783  | -1.034303 |
| 24            | 1             | 0           | 0.554965  | 0.958821  | -1.450021 |
| 25            | 1             | 0           | -1.334799 | 2.305171  | 2.162080  |
| 26            | 1             | 0           | -0.602201 | 4.621296  | 1.688125  |
| 27            | 1             | 0           | 1.295180  | 3.269593  | -1.930061 |
| 28            | 1             | 0           | 0.721105  | 5.117814  | -0.362728 |
| 29            | 1             | 0           | -0.947176 | -0.055896 | 1.781951  |
| 30            | 6             | 0           | -0.082306 | -1.017844 | 0.128906  |
| 31            | 6             | 0           | -0.385378 | -1.731502 | -0.621612 |
| 32            | 7             | 0           | 1.134006  | -1.137754 | 0.578343  |
| 33            | 8             | 0           | 1.685128  | -0.405975 | 1.448886  |
| 34            | 8             | 0           | 1.882641  | -2.183524 | 0.049213  |
| 35            | 1             | 0           | 2.835290  | -1.763673 | -0.068013 |
| 36            | 7             | 0           | 4.218317  | -1.023318 | -0.360201 |
| 37            | 6             | 0           | 5.029606  | -1.791661 | -1.312256 |
| 38            | 1             | 0           | 4.465232  | -1.933726 | -2.238864 |
| 39            | 1             | 0           | 5.257108  | -2.774001 | -0.887757 |
| 40            | 1             | 0           | 5.977045  | -1.281750 | -1.550280 |
| 41            | 6             | 0           | 4.897242  | -0.869778 | 0.934137  |
| 42            | 1             | 0           | 4.212748  | -0.378747 | 1.628618  |
| 43            | 1             | 0           | 5.822621  | -0.278885 | 0.842857  |
| 44            | 1             | 0           | 5.149037  | -1.858573 | 1.329368  |
| 45            | 6             | 0           | 3.831443  | 0.283912  | -0.913845 |
| 46            | 1             | 0           | 3.163560  | 0.783003  | -0.208100 |
| 47            | 1             | 0           | 3.294298  | 0.131732  | -1.855302 |
| 48            | 1             | 0           | 4.708724  | 0.921604  | -1.106957 |
**Ethyl glyoxalate**

| Center Number | Atomic Number | Atomic Type | Coordinates (Angstroms) |
|---------------|---------------|-------------|-------------------------|
|               |               |             | X           | Y           | Z           |
| 1             | 6             | 0           | -1.383451   | -1.495460   | 0.000000    |
| 2             | 1             | 0           | -1.355234   | -2.601259   | 0.000000    |
| 3             | 8             | 0           | -2.404854   | -0.851105   | 0.000000    |
| 4             | 6             | 0           | 0.022302    | -0.880699   | 0.000000    |
| 5             | 8             | 0           | 1.010463    | -1.588247   | 0.000000    |
| 6             | 8             | 0           | 0.000000    | 0.447424    | 0.000000    |
| 7             | 6             | 0           | 1.298458    | 1.111254    | 0.000000    |
| 8             | 1             | 0           | 1.849850    | 0.782572    | -0.886222   |
| 9             | 1             | 0           | 1.849850    | 0.782572    | -0.886222   |

**TS1**

| Center Number | Atomic Number | Atomic Type | Coordinates (Angstroms) |
|---------------|---------------|-------------|-------------------------|
|               |               |             | X           | Y           | Z           |
| 1             | 6             | 0           | 4.498099    | -2.704792   | 0.298027    |
| 2             | 6             | 0           | 4.426048    | -2.768300   | 1.690147    |
| 3             | 6             | 0           | 3.385042    | -2.111466   | 2.354628    |
| 4             | 6             | 0           | 2.426023    | -1.399351   | 1.634517    |
| 5             | 6             | 0           | 2.489610    | -1.326598   | 0.232766    |
| 6             | 6             | 0           | 3.536004    | -1.989145   | -0.420822   |
| 7             | 6             | 0           | 1.452498    | -0.551250   | -0.582797   |
| 8             | 6             | 0           | 0.066723    | -1.105731   | -0.296663   |
| 9             | 7             | 0           | -0.637766   | -0.853598   | 0.822923    |
| 10            | 8             | 0           | -0.393082   | 0.217971    | 1.514939    |
| 11            | 6             | 0           | 1.600065    | 0.999107    | -0.504185   |
| 12            | 6             | 0           | 2.991151    | 1.509580    | -0.032623   |
| 13            | 6             | 0           | 3.025805    | 3.042002    | 0.060341    |
| 14            | 6             | 0           | 2.668099    | 3.703673    | -1.275955   |
| 15            | 6             | 0           | 1.306952    | 3.190173    | -1.793712   |
| 16            | 6             | 0           | 1.319960    | 1.673625    | -1.844096   |
| 17            | 8             | 0           | 1.196924    | 1.066291    | -2.900021   |
| 18            | 6             | 0           | -1.511599   | 0.389610    | -1.551537   |
| 19            | 6             | 0           | -2.669073   | -0.579797   | -1.354444   |
| 20            | 8             | 0           | -2.511446   | -1.654682   | -2.139843   |
| 21            | 6             | 0           | -3.447668   | -2.757388   | -1.991908   |
| 22            | 6             | 0           | -2.799314   | -3.850085   | -1.157043   |
| 23            | 8             | 0           | -1.482487   | 1.463713    | -0.954581   |
| 24            | 8             | 0           | -1.608358   | -1.595020   | 1.179895    |
| 25            | 8             | 0           | -3.611832   | -0.369745   | -0.615237   |
| 26            | 7             | 0           | -2.691851   | 1.553576    | 1.991463    |
| 27            | 6             | 0           | -2.001187   | 2.315176    | 3.073488    |
| 28            | 6             | 0           | -3.524857   | 0.443793    | 2.549844    |
| 29            | 6             | 0           | -3.478869   | 2.442965    | 1.087659    |
| 30            | 1             | 0           | 2.639481    | 4.795315    | -1.178231   |
| Center Number | Atomic Number | Atomic Type | X        | Y        | Z        |
|---------------|---------------|-------------|----------|----------|----------|
| 1             | 1             | 0           | -2.834640 | -4.866030 | -0.701660 |
| 2             | 6             | 0           | -2.773320 | -3.809082 | -0.985210 |
| 3             | 6             | 0           | -3.223872 | -1.419595 | -0.206078 |
| 4             | 6             | 0           | -1.717174 | -1.064731 | -0.373732 |
| 5             | 6             | 0           | -1.296878 | -3.422649 | -1.248303 |
| 6             | 6             | 0           | -3.396629 | -2.917168 | 0.098421  |
| 7             | 1             | 0           | -3.765729 | -1.152015 | -1.124336 |
| 8             | 1             | 0           | -1.199663 | -1.401106 | 0.525608  |
| 9             | 1             | 0           | -0.691915 | -3.630603 | -0.357165 |
| 10            | 1             | 0           | -2.922386 | -3.136739 | 1.065583  |
| 11            | 1             | 0           | -3.336662 | -3.695304 | -1.921228 |
| 12            | 1             | 0           | -3.659736 | -0.824578 | 0.600113  |
| 13            | 1             | 0           | -0.882892 | -3.975216 | -2.096283 |
| 14            | 1             | 0           | -4.462113 | -3.152206 | 0.208417  |
| 15            | 6             | 0           | -1.257588 | -1.939427 | -1.543347 |
| 16            | 8             | 0           | -1.060774 | -1.501953 | -2.668313 |
| 17            | 6             | 0           | -1.419584 | 0.432012  | -0.630306 |
| 18            | 1             | 0           | -1.564781 | 0.576935  | -1.707684 |
| 19            | 6             | 0           | -2.329174 | 1.438016  | 0.069458  |
| Number | Atomic Number | Atomic Type | X (Angstroms) | Y (Angstroms) | Z (Angstroms) |
|--------|---------------|-------------|---------------|---------------|---------------|
| 20     | 6             | 0           | -3.953925     | 3.396568      | 1.285652      |
| 21     | 6             | 0           | -2.867815     | 2.494817      | -0.678041     |
| 22     | 6             | 0           | -2.621189     | 1.379021      | 1.441401      |
| 23     | 6             | 0           | -3.427273     | 2.347142      | 2.042429      |
| 24     | 6             | 0           | -3.671149     | 3.467571      | -0.079596     |
| 25     | 1             | 0           | -2.655508     | 2.556314      | -1.743155     |
| 26     | 1             | 0           | -2.219011     | 0.571245      | 2.042556      |
| 27     | 1             | 0           | -3.643898     | 2.793050      | 3.105186      |
| 28     | 1             | 0           | -4.077688     | 4.276000      | -0.681319     |
| 29     | 1             | 0           | -4.581099     | 4.149353      | 1.755305      |
| 30     | 6             | 0           | 0.059058      | 0.858779      | -0.434042     |
| 31     | 1             | 0           | 0.168103      | 1.887445      | -0.776312     |
| 32     | 6             | 0           | 1.125864      | -0.011583     | -1.180016     |
| 33     | 1             | 0           | 0.769614      | -0.045412     | -2.215310     |
| 34     | 7             | 0           | 0.498754      | 0.920438      | 1.012695      |
| 35     | 8             | 0           | 1.221297      | -3.150045     | -0.714504     |
| 36     | 6             | 0           | 2.484310      | 0.708520      | -1.193524     |
| 37     | 8             | 0           | 3.504214      | 0.257398      | -0.714868     |
| 38     | 8             | 0           | 2.386073      | 1.889103      | -1.822221     |
| 39     | 6             | 0           | 3.571567      | 2.734551      | -1.834777     |
| 40     | 1             | 0           | 4.445927      | 2.107775      | -2.026203     |
| 41     | 1             | 0           | 3.412601      | 3.402046      | -2.683696     |
| 42     | 6             | 0           | 3.699555      | 3.498183      | -0.526861     |
| 43     | 1             | 0           | 3.843622      | 2.807876      | 0.308125      |
| 44     | 1             | 0           | 2.798509      | 4.089944      | -0.336876     |
| 45     | 1             | 0           | 4.559267      | 4.174563      | -0.578153     |
| 46     | 1             | 0           | 1.748600      | -1.374165     | 0.153405      |
| 47     | 7             | 0           | 2.612549      | -1.910478     | 1.506329      |
| 48     | 6             | 0           | 3.184532      | -0.851040     | 2.344774      |
| 49     | 1             | 0           | 2.377881      | -0.237989     | 2.753591      |
| 50     | 1             | 0           | 3.822317      | -0.215449     | 1.726816      |
| 51     | 1             | 0           | 3.780574      | -1.264296     | 3.176511      |
| 52     | 6             | 0           | 3.665469      | -2.699874     | 0.858135      |
| 53     | 1             | 0           | 3.206211      | -3.455860     | 0.213322      |
| 54     | 1             | 0           | 4.313863      | -3.208820     | 1.591281      |
| 55     | 1             | 0           | 4.271191      | -2.036176     | 0.237071      |
| 56     | 6             | 0           | 1.694883      | -2.762508     | 2.267633      |
| 57     | 1             | 0           | 1.236363      | -3.494747     | 1.594332      |
| 58     | 1             | 0           | 0.903732      | -2.144468     | 2.699053      |
| 59     | 1             | 0           | 2.207413      | -3.305865     | 3.079788      |
| 60     | 8             | 0           | 1.304445      | 1.801659      | 1.313362      |
| 61     | 8             | 0           | 0.104471      | 0.059262      | 1.798008      |

**Salicylic acid (SA)**

| Center | Atomic Number | Atomic Type | Coordinates (Angstroms) |
|--------|---------------|-------------|-------------------------|
| 1       | 1             | 0           | 0.671710 -3.025229 0.000000 |
| 2       | 6             | 0           | 0.867643 -1.957824 0.000000 |
| 3       | 6             | 0           | 1.324179 0.801704 0.000000 |
| 4       | 6             | 0           | -0.228934 -1.081687 0.000000 |
| 5       | 6             | 0           | 2.162083 -1.456359 0.000000 |
| 6       | 6             | 0           | 2.400224 -0.072033 0.000000 |
| 7       | 6             | 0           | 0.000000 0.319190 0.000000 |
| 8       | 1             | 0           | 2.999827 -2.148383 0.000000 |
| Center Number | Atomic Number | Atomic Type | X     | Y     | Z     |
|---------------|---------------|-------------|-------|-------|-------|
| 1             | 6             | 0           | 5.824560 | 1.606089 | 1.508781 |
| 2             | 6             | 0           | 6.499699 | 1.540121 | 0.288607 |
| 3             | 6             | 0           | 5.887174 | 0.920590 | -0.803403 |
| 4             | 6             | 0           | 4.608377 | 0.375385 | -0.678774 |
| 5             | 6             | 0           | 3.919539 | 0.434442 | 0.542708 |
| 6             | 6             | 0           | 4.547297 | 1.055292 | 1.631321 |
| 7             | 6             | 0           | 2.505452 | -0.109958 | 0.717019 |
| 8             | 6             | 0           | 1.481159 | 0.965489 | 0.259992 |
| 9             | 7             | 0           | 1.604018 | 1.379416 | -1.188856 |
| 10            | 8             | 0           | 1.860043 | 0.526905 | -2.039321 |
| 11            | 6             | 0           | 2.263997 | -1.534876 | 0.164395 |
| 12            | 6             | 0           | 3.432171 | -2.541738 | 0.390693 |
| 13            | 6             | 0           | 3.109178 | -3.893390 | -0.269983 |
| 14            | 6             | 0           | 1.783824 | -4.915080 | 0.227162 |
| 15            | 6             | 0           | 0.621144 | -3.471506 | 0.097869 |
| 16            | 6             | 0           | 1.072590 | -2.225146 | 0.814812 |
| 17            | 8             | 0           | 0.674810 | -1.934839 | 1.944570 |
| 18            | 6             | 0           | -0.011994 | 0.584214 | 0.487495 |
| 19            | 6             | 0           | -0.936381 | 1.797637 | 0.341206 |
| 20            | 8             | 0           | -0.660147 | 2.719045 | 1.273992 |
| 21            | 6             | 0           | -1.454203 | 3.940207 | 1.239471 |
| 22            | 6             | 0           | -0.944629 | 4.885187 | 0.163738 |
| 23            | 8             | 0           | -0.442350 | -0.491107 | -0.281150 |
| 24            | 8             | 0           | 1.350827 | 2.554445 | -1.451581 |
| 25            | 8             | 0           | -1.814435 | 1.891167 | -0.490878 |
| 26            | 7             | 0           | -1.245741 | -0.176839 | -2.808482 |
| 27            | 6             | 0           | -0.555690 | -1.275692 | -3.489318 |
| 28            | 6             | 0           | -1.032736 | 1.099183 | -3.500882 |
| 29            | 6             | 0           | -2.675371 | -0.460479 | -2.638229 |
| 30            | 1             | 0           | 1.534392 | -5.401427 | -0.329841 |
| 31            | 1             | 0           | 3.596529 | -2.670496 | 1.469483 |
| 32            | 1             | 0           | 2.076387 | -1.485857 | -0.908708 |
| 33            | 1             | 0           | 0.439140 | -3.243834 | 0.958138 |
| 34            | 1             | 0           | 3.054178 | -3.748162 | -1.358083 |
| 35            | 1             | 0           | 1.880981 | -4.776945 | 1.282998 |
| 36            | 1             | 0           | 4.357140 | -2.134236 | -0.024523 |
| 37            | 1             | 0           | -0.300478 | -3.855366 | 0.541632 |
| 38            | 1             | 0           | 3.927513 | -4.599579 | -0.086572 |
| 39            | 1             | 0           | 2.319429 | -0.170941 | 1.796091 |
| 40            | 1             | 0           | 4.029830 | 1.107119 | 2.586684 |
| 41            | 1             | 0           | 4.145698 | -0.102462 | -1.535269 |
| 42            | 1             | 0           | 6.405190 | 0.859867 | -1.756741 |
| Number | Atomic Number | Atomic Type | X       | Y       | Z       |
|--------|---------------|-------------|---------|---------|---------|
| 1      | 6             | 0           | 3.166170| -0.575038| 1.561582|
| 2      | 6             | 0           | 3.798431| -0.197723| 0.367536|
| 3      | 6             | 0           | 5.098570| -0.695674| 0.092566|
| 4      | 6             | 0           | 5.715302| -1.563492| 1.016727|
| 5      | 6             | 0           | 5.058863| -1.925654| 2.186736|
| 6      | 6             | 0           | 3.778417| -1.430587| 2.471096|
| 7      | 6             | 0           | 3.101982| 0.689821 | -0.625654|
| 8      | 8             | 0           | 3.724530| 1.011674 | -1.608701|
| 9      | 8             | 0           | 1.919576| 1.082952 | -0.349512|
| 10     | 8             | 0           | -0.167832| -0.176942| -1.336903|
| 11     | 6             | 0           | -1.478864| 1.858913 | -0.375420|
| 12     | 6             | 0           | -2.735052| 1.004752 | -0.502388|
| 13     | 6             | 0           | -2.727732| -0.213612| 0.449184|
| 14     | 6             | 0           | -1.743130| -1.348156| 0.057193|
| 15     | 6             | 0           | -0.282742| -0.907875| -0.144616|

INT2'
|   |   |   |          |          |          |
|---|---|---|----------|----------|----------|
| 16| 6 | 0 | -1.309982| 2.848010 | -1.503214|
| 17| 6 | 0 | -2.472538| 3.865496 | -1.360675|
| 18| 6 | 0 | -3.832991| 3.150279 | -1.316548|
| 19| 6 | 0 | -3.882287| 2.031427 | -0.260185|
| 20| 8 | 0 | -0.812942| 1.921148 | 0.654850 |
| 21| 6 | 0 | 0.677932 | -2.103610| -0.035387|
| 22| 8 | 0 | 1.543585 | -2.148372| -1.045617|
| 23| 6 | 0 | 2.599088 | -3.144548| -0.960509|
| 24| 6 | 0 | 3.493253 | -2.935795| -2.166310|
| 25| 7 | 0 | -2.128863| -2.128655| -1.194123|
| 26| 8 | 0 | -1.735785| -2.148372| -1.243951|
| 27| 6 | 0 | -4.093405| -0.808377| 0.778777 |
| 28| 6 | 0 | -4.383279| -1.134632| 2.111142 |
| 29| 6 | 0 | -5.600003| -1.978936| 1.481761 |
| 30| 6 | 0 | -6.286299| -1.654831| 0.150840 |
| 31| 6 | 0 | -5.064169| -1.077634| -0.198264|
| 32| 8 | 0 | 0.669733 | -2.859986| 0.917498 |
| 33| 8 | 0 | -2.747824| 4.424475 | 1.383973 |
| 34| 6 | 0 | 2.509213 | 4.110783 | -0.214642|
| 35| 6 | 0 | 2.576854 | 3.029832 | 2.012703 |
| 36| 6 | 0 | -0.334118| 3.336943 | -1.438839|
| 37| 1 | 0 | -2.810333| 0.663134 | -1.534883|
| 38| 1 | 0 | -4.040030| 2.711377 | -2.302302|
| 39| 1 | 0 | -3.784715| 2.711377 | -2.302302|
| 40| 1 | 0 | -2.328281| 4.434792 | -0.432148|
| 41| 1 | 0 | -1.376901| 2.333509 | -2.467404|
| 42| 1 | 0 | -4.628534| 3.879142 | -1.121821|
| 43| 1 | 0 | -4.849616| 1.524518 | -0.300473|
| 44| 1 | 0 | -2.437677| 4.583847 | -2.187042|
| 45| 1 | 0 | -2.307690| 0.148286 | 1.396117 |
| 46| 1 | 0 | -1.753787| -2.105981| 0.841118 |
| 47| 1 | 0 | -0.037811| -0.283134| 0.723591 |
| 48| 1 | 0 | 2.137103 | -4.136511| -0.947071|
| 49| 1 | 0 | 3.134649 | -2.995873| -0.019032|
| 50| 1 | 0 | 3.913282 | -1.926215| -2.165097|
| 51| 1 | 0 | 2.934046 | -3.084084| -3.095715|
| 52| 1 | 0 | 4.320188 | -3.653311| -2.139013|
| 53| 1 | 0 | -4.865062| -0.833828| -1.235610|
| 54| 1 | 0 | -3.644310| -0.930114| 2.882958 |
| 55| 1 | 0 | -5.803686| -1.960055| 3.503156 |
| 56| 1 | 0 | -7.025654| -1.851405| -0.620958|
| 57| 1 | 0 | -7.511666| -2.428879| 1.751060 |
| 58| 1 | 0 | 1.266431 | 2.642031 | 0.496657 |
| 59| 1 | 0 | 0.036137 | 3.898043 | 2.122475 |
| 60| 1 | 0 | 0.007236 | 4.715965 | 0.545220 |
| 61| 1 | 0 | 1.113427 | 5.303860 | 1.821937 |
| 62| 1 | 0 | 3.179482 | 3.353350 | -0.619305|
| 63| 1 | 0 | 3.065551 | 4.961259 | 0.182597 |
| 64| 1 | 0 | 1.827134 | 4.443848 | -0.998016|
| 65| 1 | 0 | 3.304804 | 2.324175 | 1.616736 |
| 66| 1 | 0 | 1.948607 | 2.530892 | 2.751356 |
| 67| 1 | 0 | 3.075882 | 3.891436 | 2.459163 |
| 68| 1 | 0 | 0.662245 | 0.357953 | -1.219561|
| 69| 8 | 0 | 5.759993 | -0.376013| -1.033140|

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| Center Number | Atomic Number | Atomic Type | Coordinates (Angstroms) |
|---------------|---------------|-------------|------------------------|
|               |               |             | X     | Y     | Z     |
| 1             | 6             | 0           | -4.659446 | 0.135058 | -0.945959 |
| 2             | 6             | 0           | -4.286202 | -0.194220 | 0.368751  |
| 3             | 6             | 0           | -5.214504 | -0.877664 | 1.194895  |
| 4             | 6             | 0           | -6.485236 | -1.199243 | 0.693256  |
| 5             | 6             | 0           | -6.829369 | -0.855364 | -0.608506 |
| 6             | 6             | 0           | -5.916988 | -0.187863 | 1.439644  |
| 7             | 6             | 0           | -2.932906 | 0.123721  | 0.890637  |
| 8             | 8             | 0           | -2.590538 | -0.219507 | 2.041254  |
| 9             | 6             | 0           | -2.129828 | 0.758729  | 0.076425  |
| 10            | 8             | 0           | 0.169360  | 0.113921  | 0.367968  |
| 11            | 6             | 0           | 1.284683  | 1.568231  | 0.595258  |
| 12            | 6             | 0           | 2.575028  | 0.777153  | 0.851851  |
| 13            | 6             | 0           | 2.979659  | -0.013768 | -0.409209 |
| 14            | 6             | 0           | 1.901890  | -1.035630 | -0.864147 |
| 15            | 6             | 0           | 0.481056  | -0.420363 | -0.887155 |
| 16            | 6             | 0           | 0.699090  | 2.148779  | 1.871256  |
| 17            | 6             | 0           | 1.726023  | 3.176293  | 2.394722  |
| 18            | 6             | 0           | 3.113886  | 2.537407  | 2.583957  |
| 19            | 6             | 0           | 3.614531  | 1.820501  | 1.315538  |
| 20            | 8             | 0           | 1.235044  | 2.264920  | -0.475454 |
| 21            | 6             | 0           | -0.565446 | -1.429376 | -1.375192 |
| 22            | 8             | 0           | -1.147342 | -2.070798 | -0.362200 |
| 23            | 6             | 0           | -2.193974 | -3.021340 | -0.700416 |
| 24            | 6             | 0           | -2.683801 | -3.617209 | 0.603850  |
| 25            | 7             | 0           | 1.849268  | -2.293839 | -0.019220 |
| 26            | 8             | 0           | 1.664824  | -3.349878 | -0.625782 |
| 27            | 6             | 0           | 4.352054  | -0.671415 | -0.369804 |
| 28            | 6             | 0           | 5.140512  | -0.677240 | -1.529106 |
| 29            | 6             | 0           | 6.388364  | -1.302606 | -1.548444 |
| 30            | 6             | 0           | 6.872270  | -1.930864 | 0.398851  |
| 31            | 6             | 0           | 6.098625  | -1.927971 | 0.764138  |
| 32            | 6             | 0           | 4.848588  | -1.306539 | 0.777963  |
| 33            | 8             | 0           | -0.804212 | -1.612158 | -2.552668 |
| 34            | 8             | 0           | 1.937524  | -2.205161 | 1.201116  |
| 35            | 7             | 0           | 0.796823  | 3.662407  | 1.323249  |
| 36            | 6             | 0           | -0.113036 | 4.872160  | -1.861974 |
| 37            | 6             | 0           | -1.841525 | 4.012493  | -0.321565 |
| 38            | 6             | 0           | -1.343217 | 2.797788  | -2.410360 |
| 39            | 1             | 0           | -0.265270 | 2.623163  | 1.662006  |
| 40            | 1             | 0           | 2.385455  | 0.084771  | 1.673453  |
| 41            | 1             | 0           | 3.060727  | 1.805725  | 3.402987  |
| 42            | 1             | 0           | 3.775080  | 2.546925  | 0.507392  |
| 43            | 1             | 0           | 1.798456  | 3.995570  | 1.666699  |
| 44            | 1             | 0           | 0.530721  | 1.355312  | 2.606735  |
| 45            | 1             | 0           | 3.837469  | 3.302171  | 2.891658  |
| 46            | 1             | 0           | 4.576857  | 1.337118  | 1.512213  |
| Center Number | Atomic Number | Atomic Type | Coordinates (Angstroms) |
|---------------|---------------|-------------|-------------------------|
|               |               |             | X           | Y           | Z           |
| 1             | 6             | 0           | 5.078040    | 0.214738    | 0.183163    |
| 2             | 6             | 0           | 4.278038    | -0.520115   | -0.713550   |
| 3             | 6             | 0           | 4.848301    | -1.613489   | -1.415401   |
| 4             | 6             | 0           | 6.196557    | -1.940340   | -1.205596   |
| 5             | 6             | 0           | 6.964366    | -1.196708   | -0.318929   |
| 6             | 6             | 0           | 6.410610    | -0.113774   | 0.382798    |
| 7             | 6             | 0           | 2.858025    | -0.199539   | -0.920023   |
| 8             | 8             | 0           | 2.124424    | -0.824991   | -1.695237   |
| 9             | 8             | 0           | 2.396369    | 0.815513    | -0.184258   |
| 10            | 8             | 0           | -0.249679   | 0.640140    | 0.073556    |
| 11            | 6             | 0           | -1.218502   | 1.477694    | -0.640655   |
| 12            | 6             | 0           | -2.447673   | 0.617040    | -0.978342   |
| 13            | 6             | 0           | -3.045222   | 0.012264    | 0.308938    |
| 14            | 6             | 0           | -1.971071   | -0.705033   | 1.169472    |
| 15            | 6             | 0           | -0.719294   | 0.186199    | 1.332470    |
| 16            | 6             | 0           | -0.509681   | 1.937105    | -1.915348   |
| 17            | 6             | 0           | -1.481336   | 2.758593    | -2.776478   |
| 18            | 6             | 0           | -2.771218   | 1.978056    | -3.076568   |
| 19            | 6             | 0           | -3.442729   | 1.457171    | -1.794857   |
|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 20 | 8 | 0 | -1.602274 | 2.536499 | 0.174209 |
| 21 | 6 | 0 | 0.420192 | -0.516317 | 2.073494 |
| 22 | 8 | 0 | 1.054934 | -1.367998 | 1.271413 |
| 23 | 6 | 0 | 2.125121 | -2.180439 | 1.831133 |
| 24 | 6 | 0 | 2.311186 | -3.353189 | 0.889154 |
| 25 | 7 | 0 | -1.553368 | -2.054541 | 0.615442 |
| 26 | 8 | 0 | -1.503061 | -2.984397 | 1.419456 |
| 27 | 6 | 0 | -4.266620 | -0.873141 | 0.111437 |
| 28 | 6 | 0 | -5.329848 | -0.780974 | 1.020408 |
| 29 | 8 | 0 | -6.454138 | -1.598635 | 0.897184 |
| 30 | 6 | 0 | -6.533277 | -2.523708 | -0.146023 |
| 31 | 6 | 0 | -5.482230 | -2.621956 | 1.419456 |
| 32 | 6 | 0 | -4.357150 | -1.805178 | -0.932840 |
| 33 | 8 | 0 | 0.665216 | -0.322076 | 3.245810 |
| 34 | 8 | 0 | -1.244618 | -2.142615 | -0.568552 |
| 35 | 7 | 0 | 0.569484 | 3.955049 | 1.087773 |
| 36 | 6 | 0 | -0.110948 | 5.160211 | 1.578112 |
| 37 | 6 | 0 | 1.620721 | 4.298299 | 0.123732 |
| 38 | 6 | 0 | 1.116320 | 3.168707 | 2.201380 |
| 39 | 1 | 0 | 0.367575 | 2.534408 | -1.644402 |
| 40 | 1 | 0 | -2.076379 | -0.193794 | 2.456751 |
| 41 | 1 | 0 | -3.791141 | 2.297477 | -3.724502 |
| 42 | 1 | 0 | -1.731081 | 3.679367 | -2.234793 |
| 43 | 1 | 0 | -0.150228 | 1.053276 | -2.456751 |
| 44 | 1 | 0 | -3.470839 | 2.611083 | -3.635697 |
| 45 | 1 | 0 | -4.319692 | 0.851437 | -2.046651 |
| 46 | 1 | 0 | -0.987848 | 3.055130 | -3.709176 |
| 47 | 1 | 0 | -3.347960 | 0.856079 | 0.943122 |
| 48 | 1 | 0 | -2.373075 | -0.943839 | 2.154118 |
| 49 | 1 | 0 | -1.028508 | 1.032679 | 1.950996 |
| 50 | 1 | 0 | 1.835929 | -2.492213 | 2.837759 |
| 51 | 1 | 0 | 3.017273 | -1.550092 | 1.899221 |
| 52 | 1 | 0 | 2.585402 | -3.012898 | -0.112673 |
| 53 | 1 | 0 | 1.381447 | -3.926640 | 0.819067 |
| 54 | 1 | 0 | 3.104163 | -4.007426 | 1.265445 |
| 55 | 1 | 0 | -3.548077 | -1.897512 | -1.649184 |
| 56 | 1 | 0 | -5.276434 | -0.058687 | 1.832071 |
| 57 | 1 | 0 | -7.267563 | -1.509215 | 1.612120 |
| 58 | 1 | 0 | -5.535891 | -3.336364 | -1.877549 |
| 59 | 1 | 0 | -7.407912 | -3.160287 | -0.247602 |
| 60 | 1 | 0 | 0.775053 | 3.063126 | 0.416208 |
| 61 | 1 | 0 | -0.919847 | 4.871294 | 2.256283 |
| 62 | 1 | 0 | -0.544273 | 5.701752 | 0.731623 |
| 63 | 1 | 0 | 0.575261 | 5.836121 | 2.115411 |
| 64 | 1 | 0 | 2.110413 | 3.384537 | -0.224455 |
| 65 | 1 | 0 | 2.387152 | 4.957119 | 0.566225 |
| 66 | 1 | 0 | 1.176074 | 4.810412 | -0.735266 |
| 67 | 1 | 0 | 1.589688 | 2.262947 | 1.813730 |
| 68 | 1 | 0 | 0.308139 | 2.878115 | 2.879287 |
| 69 | 1 | 0 | 1.867430 | 3.734290 | 2.778051 |
| 70 | 1 | 0 | 1.401161 | 0.798255 | -0.228278 |
| 71 | 8 | 0 | 4.140197 | -2.376727 | -2.273545 |
| 72 | 1 | 0 | 6.612577 | -2.782077 | -1.749813 |
| 73 | 1 | 0 | 8.007018 | -1.462356 | -0.167185 |
| 74 | 1 | 0 | 7.018226 | 0.459613 | 1.075513 |
| 75 | 1 | 0 | 4.628776 | 1.044065 | 0.718472 |
### Chemical Structure

**10aaa + N(+)HMe₃ + SA(-)**

| Center Number | Atomic Number | Atomic Type | Coordinates (Angstroms) |
|---------------|---------------|-------------|-------------------------|
|               |               |             | X           | Y           | Z           |
| 1             | 6             | 0           | -6.215513   | 1.028281   | -1.240996   |
| 2             | 6             | 0           | -6.713723   | 0.975260   | 0.062602    |
| 3             | 6             | 0           | -5.891003   | 0.521370   | 1.095955    |
| 4             | 6             | 0           | -4.578717   | 0.126202   | 0.830199    |
| 5             | 6             | 0           | -4.066957   | 0.176527   | -0.475073   |
| 6             | 6             | 0           | -4.903810   | 0.630296   | -1.504012   |
| 7             | 6             | 0           | -2.632136   | -0.210840  | -0.798863   |
| 8             | 6             | 0           | -1.66189    | 0.984027   | -0.589101   |
| 9             | 7             | 0           | -1.736483   | 1.584461   | 0.798091    |
| 10            | 8             | 0           | -1.639481   | 0.831796   | 1.773181    |
| 11            | 6             | 0           | -2.127572   | -1.502755  | -0.120067   |
| 12            | 6             | 0           | -2.960147   | -2.744841  | -0.475782   |
| 13            | 6             | 0           | -2.410684   | -3.986443  | 0.246853    |
| 14            | 6             | 0           | -0.915533   | -4.205729  | -0.037783   |
| 15            | 6             | 0           | -0.093659   | -2.950112  | 0.293148    |
| 16            | 6             | 0           | -0.651300   | -1.755981  | -0.479505   |
| 17            | 8             | 0           | -0.543324   | -1.934551  | -1.854543   |
| 18            | 6             | 0           | -0.204812   | 0.545984   | -0.844711   |
| 19            | 6             | 0           | 0.789478    | 1.653528   | -0.545977   |
| 20            | 8             | 0           | 0.686535    | 2.631008   | -1.441153   |
| 21            | 6             | 0           | 1.522909    | 3.810685   | -1.228279   |
| 22            | 6             | 0           | 0.903079    | 4.724687   | -0.184788   |
| 23            | 8             | 0           | 0.131551    | -0.582303  | 0.067067    |
| 24            | 8             | 0           | -1.820106   | 2.805437   | 0.884344    |
| 25            | 8             | 0           | 1.532956    | 1.654410   | 0.416837    |
| 26            | 7             | 0           | 1.187688    | 0.009288   | 2.712532    |
| 27            | 6             | 0           | 0.418064    | -0.969877  | 3.540561    |
| 28            | 6             | 0           | 1.091606    | 1.386156   | 3.301385    |
| 29            | 6             | 0           | 2.612269    | -0.414760  | 2.520383    |
| 30            | 1             | 0           | -0.538159   | -5.058433  | 0.539060    |
| 31            | 1             | 0           | -2.926730   | -2.897148  | -1.561381   |
| 32            | 1             | 0           | -2.153034   | -1.367962  | 0.964637    |
| 33            | 1             | 0           | -0.155816   | -2.742484  | 1.366501    |
| 34            | 1             | 0           | -2.555704   | -3.859426  | 1.330220    |
| 35            | 1             | 0           | -0.776288   | -4.444799  | -1.098716   |
| 36            | 1             | 0           | -0.2007935  | -2.579557  | -0.201600   |
| 37            | 1             | 0           | 0.959710    | -3.070846  | 0.023343    |
| 38            | 1             | 0           | -2.985019   | -4.874031  | -0.045378   |
| 39            | 1             | 0           | -2.568247   | -0.383832  | -1.880062   |
| 40            | 1             | 0           | -4.523219   | 0.669614   | -2.522165   |
| 41            | 1             | 0           | -3.952173   | -0.219298  | 1.645517    |
| 42            | 1             | 0           | -6.270229   | 0.473113   | 2.113204    |
| 43            | 1             | 0           | -6.847513   | 1.374449   | -2.054303   |
| 44            | 1             | 0           | -7.355201   | 1.281339   | 0.270994    |
| 45            | 1             | 0           | -1.924545   | 1.813758   | -1.245662   |
| 46            | 1             | 0           | -0.126879   | 0.312818   | -1.909211   |
| 47            | 1             | 0           | 2.522629    | 3.469116   | -0.954144   |
| 48            | 1             | 0           | 1.558408    | 4.281182   | -2.212226   |
| 49            | 1             | 0           | 0.863181    | 4.229352   | 0.788977    |
| Center | Atomic Number | Atomic Number | Type | Coordinates (Angstroms) |
|--------|---------------|---------------|------|-------------------------|
|        |               |               |      | X           | Y           | Z           |
| 1      | 6             | 0             |      | -1.539675   | -0.272892   | 2.073957    |
| 2      | 6             | 0             |      | -1.204472   | -1.645582   | 4.160444    |
| 3      | 6             | 0             |      | 0.093881    | -2.187723   | 2.040786    |
| 4      | 6             | 0             |      | -0.540579   | -2.750785   | 3.323084    |
| 5      | 6             | 0             |      | -0.957855   | -1.423360   | 1.220224    |
| 6      | 6             | 0             |      | -2.208168   | -0.831868   | 3.330661    |
| 7      | 1             | 0             |      | -0.431862   | -0.964602   | 4.537447    |
| 8      | 1             | 0             |      | 0.915600    | -1.512355   | 2.307022    |
| 9      | 1             | 0             |      | -1.295702   | -3.500691   | 3.045350    |
| 10     | 1             | 0             |      | -1.798391   | -2.097205   | 1.034673    |
| 11     | 1             | 0             |      | -3.055515   | -1.457054   | 3.024986    |
| 12     | 1             | 0             |      | -1.707772   | -2.079227   | 5.032930    |
| 13     | 1             | 0             |      | 0.524115    | -2.996376   | 1.440362    |
| 14     | 1             | 0             |      | 0.218002    | -3.272165   | 3.919733    |
| 15     | 1             | 0             |      | -2.606589   | 0.010818    | 3.906777    |
| 16     | 8             | 0             |      | -0.586330   | 0.669055    | 2.488592    |
| 17     | 6             | 0             |      | -0.456451   | -0.891391   | -0.138397   |
| 18     | 1             | 0             |      | 0.338237    | -0.163855   | 0.061529    |
| 19     | 6             | 0             |      | -1.529413   | -0.026618   | -0.845948   |
| 20     | 1             | 0             |      | -1.083722   | 0.515266    | -1.680036   |
| 21     | 6             | 0             |      | -2.155298   | 0.995176    | 0.139282    |
| 22     | 1             | 0             |      | -1.337864   | 1.694017    | 0.356967    |
| Center Number | Atomic Number | Atomic Type | X          | Y          | Z          |
|--------------|--------------|-------------|------------|------------|------------|
| 23           | 6            | 0           | -3.259127  | 1.804330  | -0.445817  |
| 24           | 6            | 0           | -3.332159  | 3.111400  | -0.825762  |
| 25           | 1            | 0           | -2.544447  | 3.845845  | -0.72036   |
| 26           | 6            | 0           | -4.645593  | 3.304698  | -1.370968  |
| 27           | 1            | 0           | -5.062216  | 4.218901  | -1.769967  |
| 28           | 6            | 0           | -5.272791  | 2.099789  | -1.280238  |
| 29           | 1            | 0           | -6.258885  | 1.748961  | -1.544780  |
| 30           | 8            | 0           | -4.443150  | 1.170303  | -0.719798  |
| 31           | 6            | 0           | -0.118305  | -1.926291 | -1.091983  |
| 32           | 6            | 0           | 1.206803   | -3.749360 | -2.941001  |
| 33           | 6            | 0           | -0.396440  | -3.225388 | -1.200699  |
| 34           | 6            | 0           | 1.78259    | -1.553341 | -1.930797  |
| 35           | 6            | 0           | 1.72172    | -2.453951 | -2.847437  |
| 36           | 6            | 0           | 0.145933   | -4.130380 | -2.116055  |
| 37           | 1            | 0           | -1.222807  | -3.535552 | -0.569500  |
| 38           | 1            | 0           | 1.580541   | -0.545355 | -1.862046  |
| 39           | 1            | 0           | 2.547930   | -2.145439 | -3.482208  |
| 40           | 1            | 0           | -0.262105  | -5.135297 | -2.182923  |
| 41           | 1            | 0           | 1.629150   | -4.456123 | -3.649908  |
| 42           | 7            | 0           | -2.599759  | -0.865524 | -1.499977  |
| 43           | 8            | 0           | -3.215912  | -1.679987 | -0.814811  |
| 44           | 8            | 0           | -2.806061  | -0.674948 | -2.697750  |
| 45           | 1            | 0           | 0.217446   | 0.747543  | 1.904976   |
| 46           | 7            | 0           | 1.600345   | 1.552715  | 1.040036   |
| 47           | 6            | 0           | 2.752363   | 1.230405  | 0.517585   |
| 48           | 6            | 0           | 1.152762   | 2.929754  | 0.844800   |
| 49           | 1            | 0           | 1.705278   | 3.606393  | 1.516677   |
| 50           | 1            | 0           | 0.098596   | 2.996574  | 1.129869   |
| 51           | 6            | 0           | 1.384957   | 3.354864  | -0.603602  |
| 52           | 1            | 0           | 0.843480   | 2.672099  | -1.269835  |
| 53           | 1            | 0           | 1.026669   | 4.370416  | -0.801282  |
| 54           | 6            | 0           | 2.884252   | 3.280499  | -0.862552  |
| 55           | 1            | 0           | 3.095462   | 3.265898  | -1.939841  |
| 56           | 1            | 0           | 3.384220   | 4.165964  | -0.446433  |
| 57           | 6            | 0           | 3.233541   | -0.185422 | 0.818770   |
| 58           | 1            | 0           | 2.325515   | -0.784388 | 0.903911   |
| 59           | 1            | 0           | 3.684031   | -0.192782 | 1.820498   |
| 60           | 6            | 0           | 4.186820   | -0.830800 | -0.190465  |
| 61           | 1            | 0           | 3.868472   | -0.581868 | -1.207582  |
| 62           | 1            | 0           | 4.093310   | -1.927079 | -0.113233  |
| 63           | 6            | 0           | 5.647470   | -0.422980 | 0.023164   |
| 64           | 1            | 0           | 6.239178   | -0.704757 | -0.856982  |
| 65           | 1            | 0           | 6.069942   | -0.969127 | 0.876184   |
| 66           | 6            | 0           | 5.779759   | 1.085359  | 0.275859   |
| 67           | 1            | 0           | 6.822041   | 1.393088  | 0.134304   |
| 68           | 1            | 0           | 5.527044   | 1.330801  | 1.314628   |
| 69           | 6            | 0           | 4.908797   | 1.934752  | -0.651254  |
| 70           | 1            | 0           | 4.974535   | 1.563792  | -1.685155  |
| 71           | 1            | 0           | 5.308405   | 2.955759  | -0.664497  |
| 72           | 7            | 0           | 3.493390   | 2.076921  | -0.264460  |
| 73           | 8            | 0           | -2.600142  | 0.375567  | 1.331540   |
|   |   |   | 0  | 1   | 2  |
|---|---|---|----|-----|----|
| 1 | 6 | 0 | -2.782125 | -1.960714 | -1.067130 |
| 2 | 6 | 0 | -4.832865 | -2.536686 | -2.457864 |
| 3 | 6 | 0 | -4.140901 | -0.122964 | -2.167789 |
| 4 | 6 | 0 | -5.322648 | -1.087907 | -2.329769 |
| 5 | 6 | 0 | -3.250557 | -0.491217 | -0.970478 |
| 6 | 6 | 0 | -3.960254 | -2.917762 | -1.256969 |
| 7 | 1 | 0 | -4.247087 | -2.645120 | -3.379490 |
| 8 | 1 | 0 | -3.526957 | -0.146444 | -3.078319 |
| 9 | 1 | 0 | -5.983852 | -1.004123 | -1.454643 |
| 10| 1 | 0 | -3.842431 | -0.421836 | -0.050229 |
| 11| 1 | 0 | -4.554216 | -2.887833 | -0.335914 |
| 12| 1 | 0 | -5.681864 | -3.227117 | -2.532430 |
| 13| 1 | 0 | -4.499484 | 0.905659  | -2.049790 |
| 14| 1 | 0 | -5.919736 | -0.806036 | -3.205993 |
| 15| 1 | 0 | -3.556339 | -3.931462 | -1.356930 |
| 16| 8 | 0 | -1.916247 | -2.153289 | -2.184117 |
| 17| 6 | 0 | -2.026132 | 0.456701  | -0.838718 |
| 18| 1 | 0 | -1.608616 | 0.606149  | -1.846677 |
| 19| 6 | 0 | -1.264883 | -1.465332 | 0.803080  |
| 20| 1 | 0 | -0.311214 | -1.974458 | 0.967149  |
| 21| 6 | 0 | -1.823620 | -1.154450 | 2.167102  |
| 22| 6 | 0 | -1.214439 | -0.873657 | 3.355310  |
| 23| 1 | 0 | -0.149973 | -0.909561 | 3.537277  |
| 24| 6 | 0 | -2.255167 | -0.497929 | 4.271720  |
| 25| 1 | 0 | -2.145243 | -0.214898 | 5.309726  |
| 26| 6 | 0 | -3.421878 | -0.580129 | 3.575676  |
| 27| 1 | 0 | -4.458989 | -0.418523 | 3.827670  |
| 28| 8 | 0 | -3.177522 | -0.978412 | 2.287663  |
| 29| 6 | 0 | -2.437649 | 1.840710  | -0.337802 |
| 30| 6 | 0 | -3.300449 | 4.378317  | 0.543365  |
| 31| 6 | 0 | -2.583665 | 2.114321  | 1.029059  |
| 32| 6 | 0 | -2.723255 | 2.862551  | -1.253078 |
| 33| 6 | 0 | -3.152688 | 4.119782  | -0.821275 |
| 34| 6 | 0 | -3.009882 | 3.369746  | 1.466289  |
| 35| 1 | 0 | -2.343983 | 1.348163  | 1.758155  |
| 36| 1 | 0 | -2.601584 | 2.672068  | -2.316998 |
| 37| 1 | 0 | -3.365447 | 4.897137  | -1.550895 |
| 38| 1 | 0 | -3.112879 | 3.559749  | 2.531872  |
| 39| 1 | 0 | -3.631347 | 5.355816  | 0.884200  |
| 40| 1 | 0 | -1.125898 | -1.608564 | -2.026319 |
| 41| 8 | 0 | -2.143326 | -2.386940 | 0.131696  |
| 42| 6 | 0 | -0.978754 | -0.222083 | 0.000625  |
| 43| 7 | 0 | 0.223611  | 0.333353  | 0.099119  |
| 44| 8 | 0 | 1.126467 | -0.181335 | 0.905688  |
| 45| 8 | 0 | 0.527619 | 1.384015  | -0.569771 |
| 46| 1 | 0 | 2.548397 | 0.512732  | 0.357095  |
| 47| 7 | 0 | 3.477336 | 0.846845  | 0.000055  |
| 48| 6 | 0 | 4.348153 | -0.060543 | -0.388430 |
| 49| 7 | 0 | 5.531859 | 0.267824  | -0.923524 |
| 50| 6 | 0 | 5.920656 | 1.683315  | -1.051710 |
| 51| 1 | 0 | 6.602005 | 1.764121  | -1.902069 |
| 52| 1 | 0 | 6.466470 | 1.992184  | -0.151061 |
| 53| 6 | 0 | 4.682243 | 2.552846  | -1.265466 |
| 54| 1 | 0 | 4.236843 | 2.316287  | -2.238165 |
| 55| 1 | 0 | 4.970873 | 3.607305  | -1.273934 |
| 56| 6 | 0 | 3.668183 | 2.288193  | -0.156268 |
10aad' + DBU

| Center Number | Atomic Number | Atomic Type | Coordinates (Angstroms) |
|---------------|---------------|-------------|-------------------------|
|               |               |             | X            | Y            | Z            |
| 1             | 6             | 0           | 1.099071     | -2.232123   | 0.033450     |
| 2             | 6             | 0           | -0.061775    | -4.243369   | 1.012547     |
| 3             | 6             | 0           | -0.696148    | -1.903851   | 1.802376     |
| 4             | 6             | 0           | -0.574497    | -3.388378   | 2.181762     |
| 5             | 6             | 0           | 0.628343     | -1.377333   | 1.236182     |
| 6             | 6             | 0           | 1.258918     | -3.693878   | 0.454868     |
| 7             | 1             | 0           | -0.807608    | -4.249340   | 0.208553     |
| 8             | 1             | 0           | -1.488583    | -1.769515   | 1.068373     |
| 9             | 1             | 0           | 0.120877     | -3.482079   | 3.028762     |
| 10            | 1             | 0           | 1.394403     | -1.514522   | 2.012382     |
| 11            | 1             | 0           | 2.050627     | -3.754088   | 1.211019     |
| 12            | 1             | 0           | 0.075192     | -5.282743   | 1.334221     |
| 13            | 1             | 0           | -0.980240    | -1.312355   | 2.678962     |
| 14            | 1             | 0           | -1.545566    | -3.763035   | 2.528291     |
| 15            | 1             | 0           | 1.589175     | -4.263968   | -0.420429    |
| 16            | 8             | 0           | 0.239408     | -2.220279   | -1.069622    |
| 17            | 6             | 0           | 0.622696     | 0.125507    | 0.859726     |
| 18            | 1             | 0           | -0.018355    | 0.260617    | -0.016671    |
| 19            | 6             | 0           | 2.066530     | 0.454570    | 0.437163     |
| 20            | 6             | 0           | 2.499317     | -0.435037   | -0.757786    |
| 21            | 1             | 0           | 1.822480     | -0.249447   | -1.600332    |
| 22            | 6             | 0           | 3.883515     | -0.132698   | -1.208026    |
| 23            | 6             | 0           | 4.397343     | 0.309522    | -2.390138    |
| 24            | 1             | 0           | 3.836270     | 0.497116    | -3.295139    |
| 25            | 6             | 0           | 5.808263     | 0.473640    | -2.185494    |
| 26            | 1             | 0           | 6.541241     | 0.807214    | -2.906565    |
| 27            | 6             | 0           | 6.045383     | 0.122272    | -0.891585    |
| 28            | 1             | 0           | 6.935124     | 0.075751    | -0.281913    |
| 29            | 8             | 0           | 4.883552     | -0.247385   | -0.275764    |
| 30            | 6             | 0           | 0.086395     | 1.020560    | 1.959696     |
| 31            | 6             | 0           | -0.998021    | 2.634671    | 3.993524     |
| 32            | 6             | 0           | 0.810149     | 1.271123    | 3.133514     |
| 33            | 6             | 0           | -1.189435    | 1.585224    | 1.828280     |
|   |   |   |   |   |
|---|---|---|---|---|
| 34 | 6 | 0 | -1.730379 | 2.385739 | 2.830723 |
| 35 | 6 | 0 | 0.273548  | 2.073859 | 4.141747 |
| 36 | 1 | 0 | 1.797740  | 0.838269 | 3.267954 |
| 37 | 1 | 0 | -1.766395 | 1.388742 | 0.922901 |
| 38 | 1 | 0 | -2.721169 | 2.813880 | 2.705127 |
| 39 | 1 | 0 | 0.849413  | 2.260734 | 5.044046 |
| 40 | 1 | 0 | -1.413817 | 3.259758 | 4.778857 |
| 41 | 1 | 0 | -0.245317 | -1.367702 | -1.269699 |
| 42 | 7 | 0 | -1.360763 | -0.134955 | -1.981010 |
| 43 | 6 | 0 | -2.604814 | -0.097508 | -1.583426 |
| 44 | 6 | 0 | -0.830220 | 1.035774 | -2.676881 |
| 45 | 1 | 0 | -1.116849 | 0.88470  | -3.739548 |
| 46 | 1 | 0 | 0.260849  | 1.002854 | -2.636738 |
| 47 | 6 | 0 | -1.348336 | 2.332317 | -2.062016 |
| 48 | 1 | 0 | -0.981646 | 2.411812 | -1.034124 |
| 49 | 1 | 0 | -0.984924 | 3.210579 | -2.605744 |
| 50 | 6 | 0 | -2.869377 | 2.309379 | -2.085203 |
| 51 | 1 | 0 | -3.270805 | 3.069591 | -1.403977 |
| 52 | 1 | 0 | -3.246632 | 2.544074 | -3.090382 |
| 53 | 6 | 0 | -3.138775 | -1.402223 | -1.013067 |
| 54 | 1 | 0 | -2.257252 | -2.009096 | -0.804369 |
| 55 | 1 | 0 | -3.674264 | -1.936265 | -1.809208 |
| 56 | 6 | 0 | -4.035990 | -1.275347 | 0.228736 |
| 57 | 1 | 0 | -3.682731 | -0.437623 | 0.843846 |
| 58 | 1 | 0 | -3.927048 | -2.172119 | 0.849295 |
| 59 | 6 | 0 | -5.514253 | -1.077119 | -0.13956 |
| 60 | 1 | 0 | -6.056431 | -0.669574 | 0.722538 |
| 61 | 1 | 0 | -5.971705 | -2.047924 | -0.369232 |
| 62 | 6 | 0 | -5.694417 | -0.148701 | -1.349553 |
| 63 | 1 | 0 | -6.741933 | 0.169109 | -1.409317 |
| 64 | 1 | 0 | -5.485173 | -0.677769 | -2.286489 |
| 65 | 6 | 0 | -4.838788 | 1.116934 | -1.295275 |
| 66 | 1 | 0 | -4.905394 | 1.572437 | -0.295190 |
| 67 | 1 | 0 | -5.264503 | 1.844719 | -1.995564 |
| 68 | 7 | 0 | -3.416526 | 1.001559 | -1.675053 |
| 69 | 8 | 0 | 2.429383  | -1.793587 | -0.343878 |
| 70 | 1 | 0 | 2.771748  | 0.314896 | 1.255369 |
| 71 | 7 | 0 | 2.199622  | 1.903085 | 0.058910 |
| 72 | 8 | 0 | 1.557768  | 2.299716 | -0.914142 |
| 73 | 8 | 0 | 2.943313  | 2.608980 | 0.735051 |

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