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Traceless chirality transfer from a norbornene \( \beta \)-amino acid to pyrimido[2,1-\(a \)]isoindole enantiomers

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Abstract
The synthesis of two enantiomeric pairs of pyrimidoisoindoles \( 9a, 9b \) and \( 10a, 10b \) is reported. During a domino ring-closure reaction, followed by cycloreversion, the chirality of \( \text{diendo}-(\pm)\text{-}(1R,2S,3R,4S)\text{-}3\text{-amino bicyclo}[2.2.1]hept-5-ene-2-carboxamide \} \) was successfully transferred to heterocycles \(+\).\(-\)\( 9a, (\pm)\text{-}10a, (\pm)\text{-}9b, (\pm)\text{-}10b \) and \( (\pm)\text{-}10c \).

1. Introduction
Several pyrimido[2,1-\(a \)]isoindoles are well known for their potential biological and pharmacological properties such as prolatin-inhibition,\(^1\) antidepressant and diuretic,\(^2\) anxiolytic,\(^3\) vasorelaxant,\(^4\) antiplasmodial\(^5\) and antifungal\(^6\) activity. In contrast to these findings, derivatives of these heterocycles are still insufficiently studied, even less their enantiomers. To our best knowledge so far, as single enantiomers, \( \pm \) isoindoloquinazolines were prepared by a known literature protocol.\(^7\) A preparative-scale resolution of racemic ethyl \( \text{diendo}-(\pm)\text{-}(1R,2S,3R,4S)\text{-}3\text{-amino bicyclo}[2.2.1]hept-5-ene-2-carboxylates \} \) was achieved by adopting the diastereomeric salt formation with \((\pm)\text{-}10c\)\(-\)mandelic acid.\(^8\) The reaction afforded ethyl \( (\pm)\text{-}(1R,2S,3R,4S)\text{-}3\text{-aminobicyclo}[2.2.1]hept-5-ene-2-carboxylate \} \) applied in the synthesis of \( (\pm)\text{-}(1R,2S,3R,4S)\text{-}3\text{-aminobicyclo}[2.2.1]hept-5-ene-2-carboxamide \} \). In preliminary studies on the three-step domino reaction,\(^9\) racemic \( \text{diendo}-(\pm)\text{-}3\text{-amino norbornene-2-carboxamide} \} \) was reacted with 2-formylbenzoic acid (\( R = H \)), 2-acetylbenzoic acid (\( R = \text{Me} \)) or 2-(4-methylbenzoyl)benzoic acid (\( R = \text{4-MeC}_6\text{H}_4 \)) in toluene under reflux in the presence of \( p \)-toluenesulfonic acid (\( p\text{-TSA} \)) as catalyst. The reaction mixture of \( (\pm)\text{-}1 \) (monitored by TLC) was transferred to a neutral \( \text{Al}_2\text{O}_3 \) column and the cyclization products \( (\pm)\text{-}2a-4b \) were eluted with EtOAc. The solvent was then removed and diastereomeric ratios of \( (\pm)\text{-}2a-4a \) and \( (\pm)\text{-}2b-4b \) were determined by the integration of \( ^1\text{H} \) NMR spectra. The diastereomERICALLY pure isoindoloquinazolinones were readily separated by silica gel chromatography \[ \text{n-hexane-EtOAc (2:1)} \]. The structures of \( (\pm)\text{-}2a, (\pm)\text{-}2b, (\pm)\text{-}3a \) and \( (\pm)\text{-}3b, (\pm)\text{-}4a \) and \( (\pm)\text{-}4b \) were elucidated on the basis of spectroscopic data, in particular, information acquired by 2D-NMR (\text{Scheme 1} ).

The relative configurations of diastereomeric pairs \( (\pm)\text{-}2a \) and \( (\pm)\text{-}2b \) as well as \( (\pm)\text{-}3a \) and \( (\pm)\text{-}3b \) were determined by employing X-ray crystallographic analysis (\text{Fig. 1} ). In accordance with the literature data, mutual NOEs were observed for \( \text{ArH}-2.6 \) and \( \text{12a-H} \) (\( \text{NCH} \)), and also for \( \text{ArH}-2.6 \) and \( 4a\text{-H} \) \( [\text{CH}(\text{C}=\text{O})] \) in \( (\pm)\text{-}4b \),\(^1\) while the structure of

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(±)-4a was supported by a strong NOE measured between ArH-2,6 and 3-H (olefinic) atoms.16

With the isoindoloquinazolinones in hand, considerable efforts were made to achieve their thermal decomposition under microwave irradiation. On the basis of the optimized reaction conditions shown in Scheme 1, pyrimidoisoindoles (±)-5a–5c were obtained almost quantitatively and in high purity from both 2a–4a and 2b–4b. Interestingly, in our earlier study,17 (±)-5a formed directly on cyclization and thermolysis through the reaction of diexo-3-amino-7-oxanorbornene-2-carboxamide with 2-formylbenzoic acid, when the non-isolated oxygen-bridged intermediate decomposed via the loss of furan in a retro Diels–Alder reaction.

To establish the generality and synthetic potential of the cyclization of (±)-1 with 2-formylbenzoic acid or 4-oxo acids followed by the easy separation of the diastereomers and the successful retro Diels–Alder reaction, the preparation of enantiomerically pure pyrimido[2,1-c]isoindoles was attempted. By the ammonolysis of ethyl (±)-(1R,2S,3R,4S)-3-amino bicyclo[2.2.1]hept-5-ene-2-carboxylate, the amorphous free base (±)-1 was obtained with an ee value about 98%. To determine the physical and optical properties of poorly crystallized (±)-1 its HCl salt was prepared. In a stereorecontrolled cyclization, (−)-1 was treated with 2-formylbenzoic acid, 2-acyetylbenzoic acid and 2-(4-toluyloyl)benzoic acid under reaction conditions similar to those presented in Scheme 1. The reactions gave epimeric pentacycle pairs (−)-6a and (−)-6b, (+)-7a and (−)-7b and 8a and (+)-8b (Scheme 2). The presence of diastereomer 6a was observed only in the proton spectrum of the crude diastereomeric mixture, and a sufficient amount of 8a was not available for further investigations. The purified isomers were subjected to microwave-assisted retro Diels–Alder reaction, resulting in the enantiomeric (+)-9a and (+)-10a from (−)-6a and (−)-7b, respectively. Furthermore, the counterpart (−)-9b and (−)-10b from (+)-6b and (−)-7b could also be obtained. The single enantiomer (−)-10c was prepared by the thermolysis of (+)-8b. The ready loss of cyclopentadiene afforded the expected enantiomers in yields of 89–97% and with ee values of >99%.

It should be noted that all spectroscopic data of the enantiopure compounds were identical with those of the racemic samples.

3. Conclusions

In conclusion, an efficient synthesis of pyrimidoisoindole enantiomers has been accomplished. The chirality of parent β-amino carboxamide (−)-1 was completely preserved during the stereo-controlled three-step domino reaction to give epimeric pairs. The effective separation of diastereomers followed by their racemization-free retro Diels–Alder reaction allowed the formation of enantiomerically pure pyrimidoisoindoles (±)-9a and (±)-10a, (−)-9b, and (−)-10b and (−)-10c.

4. Experimental

4.1. General

Melting points were determined on a Kofler apparatus and are uncorrected.1H NMR (400 Hz) and 13C NMR (100 MHz) spectra were recorded on a Bruker Avance DRX 400 spectrometer, with TMS as an internal reference and DMSO-d6 or CDCl3 as solvent. FTIR spectra were recorded on a Perkin-Elmer 100 FT-IR spectrometer. Elemental analyses were carried out on a Perkin-Elmer 2400 elemental analyser. Microwave-promoted reactions were performed in sealed reaction vials (10 mL) by means of a CEM, Discover microwave reactor. Optical rotations were measured on a Perkin-Elmer 341 polarimeter. Mass spectra were recorded on a Finnigan MAT 95S spectrometer.

The ee values of (+)-10a and (−)-10b were determined on a Chiralpak IA column (4.6 × 250 mm); detection at 332 nm; eluent: n-hexane/ Et2NH/MePA (75/0.1/25); flow rate: 0.5 mL/min; retention times (min) for (+)-10a: 23.96 (antipode, (−)-10b: 25.66). Conditions for (+)-11a and (−)-11b: Chiralpak IA column (4.6 × 250 mm); detection at 236 nm; eluent: n-hexane/ Et2NH/MePA (90/0.1/10); flow rate: 0.5 mL/min; retention times (min) for (+)-11a: 41.26 (antipode, (−)-11b: 46.02). Data for (+)-9a and (−)-9b: Chiralpak IA column (4.6 × 250 mm); detection at 220 nm; eluent: n-hexane/Et2NH/MePA (90/0.1/10); flow rate: 0.5 mL/min; retention times (min) for (+)-9a: 49.19 (antipode, (−)-9b: 51.57). The ee value of (−)-I was determined on a GC equipped with a Chrompack Chirasil-Dex CB column after a simple derivatization with Ac2O in the presence of 4-dimethylaminopyridine and pyridine [120 °C for 4 min → 170 °C (temperature rise 10 °C min−1); 140 kPa; retention times (min), (−)-I: 22.25 (antipode: 23.25)].

4.1.1. X-ray structure determination

The crystals of 2a, 2b, 3a, and 3b were immersed in cryo-oil, mounted in a MiTeGen loop, and measured at 120–170 K on a Rigaku Oxford Diffraction Supernova or on a Bruker Kappa Apex

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Scheme 1. Preparation of pyrimidoisoindoles (±)-5a–5c by domino ring closure, followed by thermal cycloreversion.
II diffractometer using Cu Kα (\(\lambda = 1.54184\ \text{Å}\)) or Mo Kα (\(\lambda = 0.71073\)) radiation. The CrysAlisPro\textsuperscript{18} or Denzo-Scalepack\textsuperscript{19} program packages were used for cell refinements and data reductions. Multi-scan absorption corrections (CrysAlisPro\textsuperscript{18} or SADABS\textsuperscript{20}) were applied to the intensities before structure solution. The structures were solved by charge flipping method using the SUPERFLIP\textsuperscript{21} software. Structural refinements were carried out using SHELXL-2014.\textsuperscript{22} The high R-values and residual densities in 3a are due to the low data quality and possible twinning. However, not satisfactory twin model could be found and therefore no twin model was used in the final refinement. In 2b and 3b the NH hydrogen atoms were located from the difference Fourier map and refined isotropically. Other hydrogen atoms were positioned geometrically and constrained to ride on their parent

**Figure 1.** ORTEP views of diastereomeric pairs 2a–2b and 3a–3b.

**Scheme 2.** Synthesis of antipode pairs [(+)-9a–(−)-9b and [(+)-10a–(−)-10b] and single enantiomeric pyrimidoisoindoles.
atoms, with C–H = 0.95–1.00 Å, N–H = 0.88 Å and Uiso = 1.2–1.5Ueq (parent atom). The crystallographic details are summarized in Table S1X.

4.2. Synthesis of isoindolo[2,1-α]quinazolines (±)-2a, (±)-2b, (±)-3a, (±)-3b, (±)-4a and (±)-4b

A mixture of diendo-3-aminobicyclo[2.2.1]hept-5-ene-2-carboxamide (±)-1, (0.76 g, 5.0 mmol) 2-formylenzobic acid, 2-acetylbenzoic acid or 2-(4-methylbenzoyl)benzoic acid (±)-1boxamide (±)-1 was stirred with 10 mL of methanol for 16 h. The solvent was then evaporated off, the residue was dissolved in 15 mL of EtOAc and the solution was transferred to a silica gel column and eluted with EtOAc. After evaporation, a small amount (10 mg) of the residue was separated to determine the diastereometric ratio by 1H NMR analysis. The major fraction was transferred to a silica gel column and eluted with a mixture of n-hexane–EtOAc (2:1).

4.2.1. (15′S,4′R,4a′S,6a′R,12a′R)-1,4,4a,6,6a,12a-Dihydroxy-1,4-methanoisoindolo[2,1-α]quinazoline-5,11-diene (±)-2a

Yield: 24%, colourless crystals, mp 302–304°C (EtOH). IR (KBr): 3218, 3112, 2961, 1683, 1665, 1654, 1470, 1398, 737 cm⁻¹. 1H NMR (400 MHz, DMSO-δ6) δ (ppm) 1.45 (1H, d, J = 8.8 Hz, H-13), 1.62 (1H, d, J = 8.7 Hz, H-13), 2.90 (1H, dd, J = 9.1 Hz, J = 4.1 Hz, H-4a), 3.17 (1H, s, H-4), 3.26 (1H, s, H-1), 5.03 (1H, dd, J = 9.1 Hz, J = 3.5 Hz, H-12a), 5.64 (1H, s, H-6a), 6.38 (1H, dd, J = 5.8 Hz, J = 2.8 Hz, H-2), 6.42 (1H, dd, J = 5.7 Hz, J = 2.8 Hz, H-3), 7.53–7.79 (4H, m, H-Ar), 8.81 (1H, s, CONH). 13C NMR (100 MHz, DMSO-δ6) δ (ppm) 42.1, 47.2, 48.8, 49.3, 51.1, 66.1, 123.8, 124.5, 130.4, 131.5, 133.0, 136.6, 137.6, 143.3, 167.2, 171.5. Anal. calcd. for C16H14N2O2 (%): C, 72.84; H, 5.75; N, 9.99. Found: C, 72.65; H, 5.95; N, 10.65. MS: (ESI) m/z = 267.32 [M+H]+.

4.2.2. (15′S,4′R,4a′S,6a′S,12a′R)-1,4,4a,6,6a,12a-Hexahydro-1,4-methanoisoindolo[2,1-α]quinazoline-5,11-diene (±)-2b

Yield: 49%, colourless crystals, mp 264–266°C (EtOAc). IR (KBr): 3244, 3045, 2968, 2870, 1673, 1661, 1466, 1348, 731 cm⁻¹. 1H NMR (400 MHz, DMSO-δ6) δ (ppm) 1.46 (2H, m, H-13), 3.03 (1H, dd, J = 8.8 Hz, J = 4.1 Hz, H-4a), 3.26 (1H, s, H-4), 4.02 (1H, s, H-1), 4.36 (1H, dd, J = 8.8 Hz, J = 3.6 Hz, H-12a), 5.80 (1H, s, H-6a), 5.95 (1H, dd, J = 6.0 Hz, J = 2.9 Hz, H-2), 6.06 (1H, dd, J = 5.6 Hz, J = 2.7 Hz, H-3), 7.51–7.74 (4H, m, H-Ar), 8.92 (1H, s, CONH). 13C NMR (100 MHz, DMSO-δ6) δ (ppm) 44.7, 46.0, 46.1, 46.2, 54.9, 66.7, 123.5, 124.5, 130.3, 132.5, 135.3, 137.7, 141.5, 165.4, 172.1. Anal. calcd. for C16H14N2O2 (%): C, 72.16; H, 5.30; N, 10.52. Found: C, 72.15; H, 5.45; N, 10.45. MS: (ESI) m/z = 201.26 [M+DAH]+ and 267.23 [M+H]+.

Table S1X

|            | 2a            | 2b            | 3a            | 3b            |
|------------|---------------|---------------|---------------|---------------|
| Empirical formula | C16H14N2O2 | C16H14N2O2 | C16H14N2O2 | C17H16N2O2 |
| fw         | 266.29        | 266.29        | 280.32        | 280.32        |
| Temp (K)   | 170(2)        | 120(2)        | 154.184       | 170(2)        |
| λ (Å)      | 0.71073       | 1.54184       | 1.54184       | 0.71073       |
| Cristyst    | Monoclinic    | Monoclinic    | Orthorhombic  | Triclinic     |
| Space group | P2/c          | P2/c          | P2/c          | P2/c          |
| a (Å)      | 6.6902(6)     | 21.07531(12)  | 17.13133(7)   | 17.13133(7)   |
| b (Å)      | 10.4134(11)   | 13.71333(7)   | 13.71333(7)   | 13.71333(7)   |
| c (Å)      | 18.0859(14)   | 8.74579(5)    | 8.74579(5)    | 8.74579(5)    |
| α (°)      | 90            | 90            | 90            | 90            |
| β (°)      | 92.658(8)     | 94.4336(5)    | 94.4336(5)    | 94.4336(5)    |
| γ (°)      | 90            | 90            | 90            | 90            |
| V(Å³)      | 1250.94(19)   | 2520.08(2)    | 2783.96(5)    | 4064.06(4)    |
| Z          | 4             | 8             | 8             | 4             |
| μcalc (Mg/m³) | 1.414         | 1.404         | 1.338         | 1.324         |
| μ(Ks) (mm⁻¹) | 0.095         | 0.762         | 0.716         | 0.888         |
| No. refls. | 4527          | 2627          | 33800         | 27156         |
| Unique refls. | 5306         | 4893          | 3066          | 7258          |
| GOOF (F²)  | 1.053         | 1.145         | 0.2771        | 0.1112        |
| R₁ (I > 2σI) | 0.0352        | 0.0291        | 0.0124        | 0.0070        |
| wR² (I > 2σI) | 0.0535        | 0.0506        | 0.0771        | 0.1112        |

* R₁ = Σ|F₁| - |F₂| / Σ|F₁|.
* wR² = [Σ(w(F₀² - F₁²)²)/Σ(w(F₁²)²)]¹/².

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4.25. (15'R,4'R,4a'S,6a'R,12aR')-6a-(p-Toly1)-1,4,4a,6,6a,12a-hexahydro-1,4-methanoisoindolo[2,1-a]quinazoline-5,11-dione (±)-4a

Yield: 3%, colourless crystals, mp 230–232 °C (EtOAc). IR (KBr): 3291, 3075, 3018, 2986, 2940, 1704, 1656, 1621, 1111, 1487, 1355, 1322, 738 cm−1. 1H NMR (400 MHz, DMSO-d6) δ (ppm) 1.38 (2H, m, H-13), 2.26 (3H, s, CH3), 2.34 (1H, dd, J = 8.8 Hz, J = 3.9 Hz, H-4a), 2.94 (1H, d, J = 10.3 Hz, CONH), 3.04 (1H, s, H-4), 3.20 (1H, H-1), 3.79 (1H, m, H-12a), 6.16 (1H, d, J = 5.6 Hz, J = 2.9 Hz, H-2), 6.23 (1H, d, J = 5.6 Hz, J = 2.9 Hz, 3-H), 7.17–7.77 (8H, m, H-Ar). 13C NMR (100 MHz, DMSO-d6) δ (ppm) 21.4, 46.3, 46.5, 46.7, 56.8, 83.9, 124.2, 125.2, 126.2 (2 C), 128.7, 130.5, 132.7, 135.3, 138.5, 138.9, 139.4, 165.9, 170.7. Anal. calcd. for C23H20N2O2 (%): C, 77.51; H, 5.66; N, 7.86. Found: C, 77.11; H, 5.66; N, 7.86. MS: (ESI) m/z = 315.4 [M+H]+ and 317.3 [M+Na]+.

4.4. Synthesis of (−)-(1R,2S,3R,4S)-3-aminoacetoxy[2.2.1]hept-5-ene-2-carboxamide (−)-1

(−)-(1R,2S,3R,4S)-Ethyl-3-aminoacetoxy[2.2.1]hept-5-ene-2-carboxylate [13] (3.5 g, 19.3 mmol) was left to stand at rt for 5 weeks in a 26% ammonia–methanol solution (200 mL). The solution was then evaporated to dryness, the residue was dissolved in EtOAc (20 mL), and the solution was transferred to a silica gel column and eluted, first with EtOAc and then with EtOAc/MeOH (3:1). The residue of the eluates afforded (−)-1 (141 g, 48%) as pale-yellow semi-crystalline solid. 100 mg of (−)-1 was treated with ethanolic hydrogen chloride to obtain crystalline (−)-1×HCl. Mp 239–241 °C (EtOH–Et2O); [α]D25 = +14.8 (c 0.485, H2O), ee > 99% (GC).

4.5. Synthesis of isoindolo[2,1-a]quinazolines (−)-6a, (+)-6b, (+)-7a, (−)-7b and (+)-8b enantiomers

A mixture of (−)-(1R,2S,3R,4S)-3-norbornene-2-carboxamide (−)-1 (350 mg, 2.3 mmol), 2-formylbenzoic acid, 2-acyltolylbenzoic acid or 2-(4-methylbenzoyl)benzoic acid (2.5 mmol), and p-TSA (0.03 g) in toluene (25 mL) was refluxed for 16 h. The solvent was then evaporated off, the residue was dissolved in EtOAc (10 mL), and the solution was transferred to a neutral Al2O3 column and eluted with EtOAc. The residue of the eluates was transferred to a silica gel column and eluted with a mixture of n-hexane–EtOAc (2:1). The 1H NMR spectra for optically active compounds were in accordance with those reported for the racemates.

4.5.1. (15'R,4'R,4a'S,6a'R,12aR')-1,4,4a,6,6a,12a-hexahydro-1,4-methanoisoindolo[2,1-a]quinazoline-5,11-dione (−)-6a

Yield: 26%, colourless crystals, mp 262–264 °C (EtOH). [α]D25 = +100.5 (c 0.48, EtOH).

4.5.2. (15'R,4'R,4a'S,6a'R,12aR')-(+)-1,4,4a,6,6a,12a-hexahydro-1,4-methanoisoindolo[2,1-a]quinazoline-5,11-dione (+)-6b

Yield: 38%, colourless crystals, mp 254–256 °C (EtOAc). [α]D25 = +138.0 (c 0.50, EtOH).

4.5.3. (15'R,4'R,4a'S,6a'R,12aR')-(+)-6a-Methyl-1,4,4a,6,6a,12a-hexahydro-1,4-methanoisoindolo[2,1-a]quinazoline-5,11-dione (+)-7a

Yield: 5%, colourless crystals, mp 258–259 °C (iPr2O–EtOAc). [α]D25 = +110.0 (c 0.19, ETOH).

4.5.4. (15'R,4'R,4a'S,6a'R,12aR')-(−)-Methyl-1,4,4a,6,6a,12a-hexahydro-1,4-methanoisoindolo[2,1-a]quinazoline-5,11-dione (−)-7b

Yield: 41%, colourless crystals, mp 141–142 °C (EtOAc). [α]D25 = −27.0 (c 0.16, ETOH).

4.5.5. (15'R,4'R,4a'S,6a'R,12aR')-(−)-6a-(p-Toly1)-1,4,4a,6,6a,12a-hexahydro-1,4-methanoisoindolo[2,1-a]quinazoline-5,11-dione (−)-8b

Yield: 34%, colourless crystals, mp 265–267 °C (iPr2O–EtOAc). [α]D25 = +106.8 (c 0.37, EtOH).

4.6. Synthesis of enantiomeric pyrimido[2,1-a]isoindole (−)-9a, (−)-9b, (+)-10a, (−)-10b and (−)-11b by microwave-induced retro Diels–Alder reaction

The reactions were performed as described for the racemates, on 25–100 mg scale. All 1H NMR spectra recorded for the enantiomeric substances were the same as those for the racemate counterparts.
4.6.1. \((R)-(+)\)-1,10b-Dihydropyrimido[2,1-\(a\)]isoindole-2,6-dione (+)-9a  
Yield: 92%, colourless crystals, mp 265–267 °C (EtOAc–\(n\)-hexane). \(|x|^2 = +441 \text{ (c 0.11, EtOH)}, \text{ ee } 99\%.

4.6.2. \((S)-(\text{--})\)-1,10b-Dihydropyrimido[2,1-\(a\)]isoindole-2,6-dione (\text{--})-9b  
Yield: 96%, colourless crystals, mp 267–269 °C (EtOAc–\(n\)-hexane). \(|x|^2 = -428 \text{ (c 0.12, EtOH)}, \text{ ee } 99\%.

4.6.3. \((R)-(+)\)-10b-Methyl-1,10b-dihydropyrimido[2,1-\(a\)]isoindole-2,6-dione (+)-10a  
Yield: 91%, colourless crystals, mp 201–202 °C (EtOAc–\(i\)-Pr\(_2\)O). \(|x|^2 = +429 \text{ (c 0.11, EtOH)}, \text{ ee 99\%}.

4.6.4. \((S)-(\text{--})\)-10b-Methyl-1,10b-dihydropyrimido[2,1-\(a\)]isoindole-2,6-dione (\text{--})-10b  
Yield: 97%, colourless crystals, mp 199–201 °C (EtOAc–\(i\)-Pr\(_2\)O). \(|x|^2 = -450 \text{ (c 0.17, EtOH)}, \text{ ee > 99\%}.

4.6.5. \((S)-(\text{--})\)-10b-(\text{p-Toly})-1,10b-dihydropyrimido[2,1-\(a\)]isoindole-2,6-dione (\text{--})-11b  
Yield: 89%, colourless crystals, mp 245–247 °C (\(i\)-Pr\(_2\)O). \(|x|^2 = -21.8 \text{ (c 0.36, EtOH), ee > 99\%}.

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A. Supplementary data  
Supplementary data (Copies of the \(^1\)H and \(^{13}\)C NMR spectra) associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.tetasy.2017.07.006.

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