

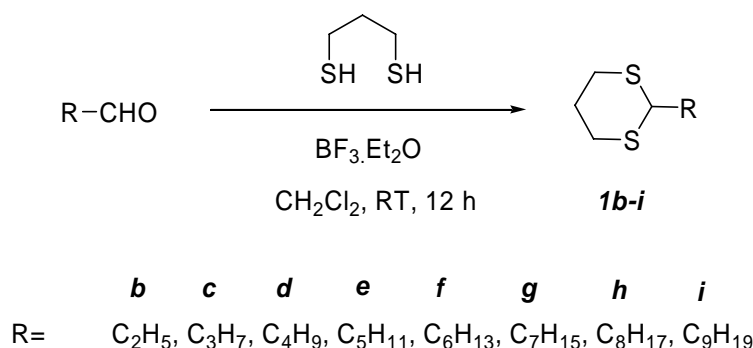
Direct Screening of Solution Phase Combinatorial Libraries Encoded with Externally Sensitized Photolabile Tags.

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Supporting Materials and Methods

Common reagents were purchased from the Sigma-Aldrich Chemical Co. and used without further purification. THF was refluxed over and distilled from potassium benzophenone ketyl prior to use. Immunopure Avidin was purchased from Pierce. ^1H and ^{13}C NMR spectra were recorded at 25°C on a Varian Mercury 400 MHz instrument, in CDCl_3 , DMSO-d_6 or CD_3OD using TMS used as an internal standard. Column chromatography was performed on silica gel, 70-230 mesh. The UV-Vis spectra were recorded on a Beckman DU-640 spectrophotometer. Irradiations were carried out in a carousel Rayonet photo reactor (RPR-3500 lamps) and a 330 nm long pass solution filter. Gas chromatography was done using a Varian Saturn 2100 T Ion-Trap GCMS utilizing Electron Ionization (EI). Selective ion monitoring m/z 119, 74 was used to separate dithiane tags following fragmentation. The initial temperature was 70°C and a final temperature of 260°C was reached at the rate of $30^\circ\text{C}/\text{min}$. The inlet temperature was 100°C and the split ratio was 100. The flow rate was 1.0 mL/min with column dimensions of 30 m X $250\ \mu\text{m}$ ID, as well as a 5% phenyl methyl siloxane fused silica bonded capillary

1. General procedure for syntheses of 1(b-i)



To a solution of substituted aldehyde (66.9 mmol) and 1, 3-propanedithiol (66.9 mmol) in methylene chloride (300 mL) was added $\text{BF}_3 \cdot \text{Et}_2\text{O}$ (0.268 mol) and stirred for 12 h at 25°C . The reaction mixture was washed with NaOH (2 x 200 mL, 5% aq. soln) and H_2O (300 mL). The organic layer was dried over anhydrous Na_2SO_4 and the solvent was removed under vacuum and dried to obtain the desired compound.

Ib, 91% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 4.01 (t, J=6.79 Hz, 1H), 2.92-2.81 (m, 4H), 2.18-2.09 (m, 1H), 1.91-1.76 (m, 3H), 1.10 (t, J=7.44 Hz, 3H);

Ic, 87% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 4.08 (t, J=6.93 Hz, 1H), 2.92-2.79 (m, 4H), 2.15-2.08 (m, 1H), 1.91-1.80 (m, 1H), 1.75-1.70 (m, 2H), 1.57-1.48 (m, 2H), 0.95 (t, J=7.32 Hz, 3H);

Id, 82% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 4.06 (t, J=6.90 Hz, 1H), 2.92-2.79 (m, 4H), 2.15-2.08 (m, 1H), 1.91-1.81 (m, 1H), 1.78-1.72 (m, 2H), 1.52-1.45 (m, 2H), 1.38-1.29 (m, 2H), 0.92 (t, J=7.29 Hz, 3H);

Ie, 94% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 4.03 (t, J=6.90 Hz, 1H), 2.92-2.79 (m, 4H), 2.15-2.08 (m, 1H), 1.92-1.80 (m, 1H), 1.77-1.71 (m, 2H), 1.56-1.47 (m, 2H), 1.36-1.26 (m, 4H), 0.91 (t, J=6.95 Hz, 3H);

If, 86% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 4.07 (t, J=6.90 Hz, 1H), 2.92-2.79 (m, 4H), 2.15-2.08 (m, 1H), 1.92-1.83 (m, 1H), 1.77-1.72 (m, 2H), 1.54-1.46 (m, 2H), 1.34-1.24 (m, 6H), 0.90 (t, J=6.79 Hz, 3H);

Ig, 91% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 4.06 (t, J=6.90 Hz, 1H), 2.91-2.78 (m, 4H), 2.14-2.07 (m, 1H), 1.91-1.80 (m, 1H), 1.76-1.71 (m, 2H), 1.51-1.45 (m, 2H), 1.31-1.22 (m, 8H), 0.89 (t, J=6.95 Hz, 3H);

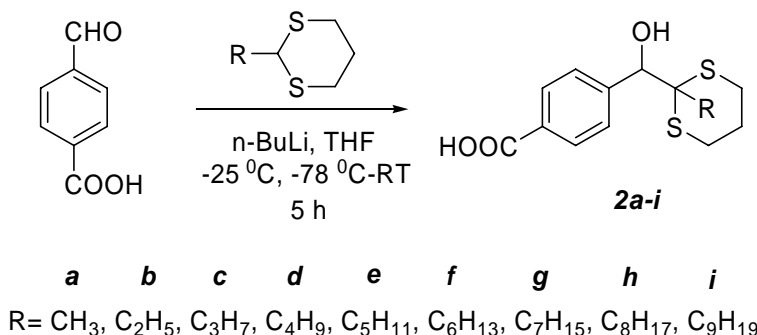
Ih, 93% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 4.05 (t, J=6.89 Hz, 1H), 2.91-2.78 (m, 4H), 2.13-2.08 (m, 1H), 1.89-1.82 (m, 1H), 1.76-1.70 (m, 2H), 1.52-1.45 (m, 2H), 1.30-1.23 (m, 10H), 0.88 (t, J=6.82 Hz, 3H);

Ii, 90% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 4.06 (t, J=6.89 Hz, 1H), 2.91-2.78 (m, 4H), 2.15-2.08 (m, 1H), 1.91-1.80 (m, 1H), 1.76-1.70 (m, 2H), 1.52-1.47 (m, 2H), 1.32-1.22 (m, 12H), 0.89 (t, J=6.88 Hz, 3H);

2. General procedure for syntheses of 2(a-i)



n-BuLi (14.58 mL, 23.3 mmol, 1.6 M solution in THF) was added at -25⁰ C to a solution of 2-alkyl-1,3-dithiane (23.3 mmol) in dry THF (40 mL) under nitrogen atmosphere. The resulting solution was stirred at this temperature for 2 h, the temperature was then reduced to -78⁰ C and 4-formylbenzoic acid (0.5 g, 3.33 mmol) in 20 mL of THF was added. After stirring at -78⁰ C for an additional 2 hr, the solution was allowed to warm to room temperature. Saturated ammonium chloride (20 mL) was added, and the aqueous phase was extracted twice with 20 mL ethyl acetate. The aqueous layer was acidified with 5% HCl, extracted with ethyl acetate (100 mL), dried over Na₂SO₄ and the solvent was removed in vacuum. The crude product was crystallized from toluene to get pure compound.

2a, 95% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 7.85 (d, J=8.34 Hz, 2H), 7.53 (d, J=8.34 Hz, 2H), 5.76 (d, J=4.50 Hz, 1H), 4.97 (d, J=4.41 Hz, 1H), 3.14-2.99 (m, 2H), 2.71-2.67 (m, 2H), 1.91 (m, 1H), 1.77 (m, 1H), 1.30 (s, 3H);

¹³C NMR (DMSO-d₆, 100 MHz): δ 167.99, 146.61, 130.35, 129.31, 128.63, 77.95, 53.59, 26.83, 26.52, 25.13, 23.96.

2b, 96% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 7.85 (d, J=8.34 Hz, 2H), 7.56 (d, J=8.34 Hz, 2H), 5.68 (d, J=4.50 Hz, 1H), 5.00 (d, J=4.41 Hz, 1H), 3.06-2.99 (m, 1H), 2.91-2.84 (m, 1H), 2.70-2.58 (m, 2H), 1.85-1.76 (m, 2H), 1.73-1.66 (m, 1H), 1.57-1.52 (m, 1H), 0.99 (t, J= 7.4 Hz, 3H);

¹³C NMR (DMSO-d₆, 100 MHz): δ 168.00, 146.85, 130.24, 129.57, 128.49, 77.29, 58.95, 29.13, 26.46, 25.91, 24.86, 9.81.

2c, 94% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 7.85 (d, J=8.40 Hz, 2H), 7.55 (d, J=8.28 Hz, 2H), 5.68 (d, J=4.50 Hz, 1H), 5.01 (d, J=4.50 Hz, 1H), 3.06-3.03 (m, 1H), 2.90-2.87 (m, 1H), 2.68-

2.59 (m, 2H), 1.84-1.83 (m, 1H), 1.72-1.66(m, 2H), 1.51-1.40 (m, 3H), 0.82 (t, J= 7.17 Hz, 3H);

¹³C NMR (DMSO-d₆, 100 MHz): δ 168.01, 146.82, 130.25, 129.54, 128.52, 77.32, 58.37, 38.63, 26.64, 26.09, 24.90, 18.16, 15.05.

2d, 92% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 7.85 (d, J=8.32 Hz, 2H), 7.55 (d, J=8.28 Hz, 2H), 5.68 (d, J=4.48 Hz, 1H), 5.01 (d, J=4.44 Hz, 1H), 3.08-3.03 (m, 1H), 2.92-2.87(m, 1H), 2.68-2.58 (m, 2H), 1.86-1.66 (m, 3H), 1.49-1.40(m, 3H), 1.21-1.16 (m, 2H), 0.83 (t, J= 7.31Hz, 3H);

¹³C NMR (DMSO-d₆, 100 MHz): δ 168.00, 146.86, 130.24, 129.55, 128.49, 77.33, 58.32, 36.11, 26.96, 26.62, 26.08, 24.90, 23.31, 14.64.

2e, 96% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 7.84 (d, J=8.10 Hz, 2H), 7.55 (d, J=8.21 Hz, 2H), 5.68 (d, J=4.45 Hz, 1H), 5.01 (d, J=4.40 Hz, 1H), 3.05-3.00 (m, 1H), 2.92-2.87(m, 1H), 2.67-2.58 (m, 2H), 1.84-1.67 (m, 3H), 1.45-1.40(m, 3H), 1.25-1.15 (m, 4H), 0.83 (t, J= 7.04 Hz, 3H);

¹³C NMR (DMSO-d₆, 100 MHz): δ 167.99, 146.86, 130.23, 129.54, 128.49, 77.32, 58.36, 36.30, 32.39, 26.62, 26.08, 24.89, 24.37, 22.70, 14.59.

2f, 92% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 7.84 (d, J=7.96 Hz, 2H), 7.55 (d, J=7.90 Hz, 2H), 5.67 (d, J=4.25 Hz, 1H), 5.01 (d, J=4.41 Hz, 1H), 3.08-3.02 (m, 1H), 2.92-2.87(m, 1H), 2.67-2.58 (m, 2H), 1.83-1.67 (m, 3H), 1.46-1.40(m, 3H), 1.21-1.15 (m, 6H), 0.83 (t, J= 6.44 Hz, 3H);

¹³C NMR (DMSO-d₆, 100 MHz): δ 167.98, 146.86, 130.22, 129.54, 128.48, 77.32, 58.35, 36.37, 31.84, 29.81, 26.62, 26.08, 24.89, 24.66, 22.71, 14.59.

2g, 95% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 7.84 (d, J=8.03 Hz, 2H), 7.55 (d, J=7.90 Hz, 2H), 5.66 (d, J=3.96 Hz, 1H), 5.00 (d, J=3.68 Hz, 1H), 3.05-3.02 (m, 1H), 2.90-2.87(m, 1H), 2.67-2.57 (m, 2H), 1.85-1.66 (m, 3H), 1.45-1.40(m, 3H), 1.27-1.19 (m, 8H), 0.83 (t, J= 6.32 Hz, 3H);

¹³C NMR (DMSO-d₆, 100 MHz): δ 167.98, 146.85, 130.22, 129.52, 128.48, 77.33, 58.35, 36.37, 31.88, 30.11, 29.28, 26.64, 26.09, 24.90, 24.69, 22.74, 14.62.

2h, 91% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 7.84 (d, J=8.36 Hz, 2H), 7.53 (d, J=8.32 Hz, 2H), 5.65 (brs, 1H), 5.00 (s, 1H), 3.08-3.02 (m, 1H), 2.92-2.87(m, 1H), 2.67-2.57 (m, 2H), 1.86-1.63 (m, 3H), 1.45-1.40(m, 3H), 1.29-1.19 (m, 10H), 0.84 (t, J= 6.85 Hz, 3H);

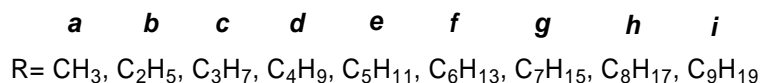
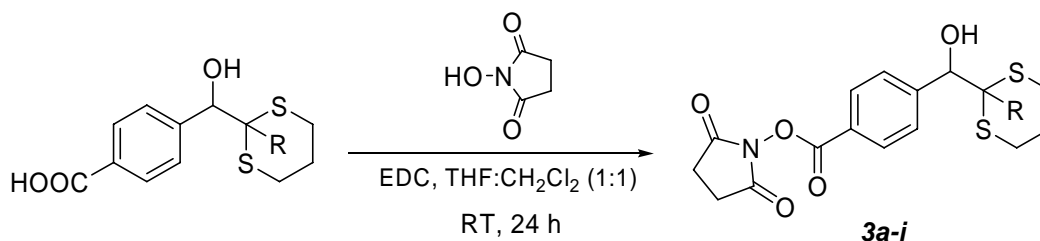
¹³C NMR (DMSO-d₆, 100 MHz): δ 168.06, 146.69, 130.55, 129.48, 128.47, 77.37, 58.35, 36.38, 31.93, 30.14, 29.56, 29.30, 26.65, 26.10, 24.89, 24.67, 22.77, 14.63.

2i, 90% Yield.

^1H NMR (DMSO- d_6 , 400 MHz): δ 7.84 (d, $J=8.29$ Hz, 2H), 7.55 (d, $J=8.32$ Hz, 2H), 5.67 (d, $J=4.48$ Hz, 1H), 5.01 (d, $J=4.44$, 1H), 3.06-3.02 (m, 1H), 2.90-2.87(m, 1H), 2.67-2.57 (m, 2H), 1.84-1.66(m, 3H), 1.45-1.39(m, 3H), 1.24-1.19 (m, 12H), 0.84 (t, $J= 6.84$ Hz, 3H);

^{13}C NMR (DMSO- d_6 , 100 MHz): δ 167.97, 146.81, 130.24, 129.51, 128.47, 77.38, 58.35, 36.38, 31.99, 30.17, 29.63, 29.37, 26.67, 26.13, 24.90, 24.67, 22.80, 14.62.

3. General procedure for syntheses of 3(a-i)



A mixture of 4-[(2-alkyl-1,3-dithian-2-yl)(hydroxyl)methyl]benzoic acid (1.60 mmol), N-hydroxysuccinimide (2.56 mmol) and EDC (2.08 mmol) was dissolved in THF:CH₂Cl₂ (1:1, 30 mL) and stirred for 24 h at room temperature. The solution was washed with 20 mL of water, 20 mL of saturated NaHCO₃, followed by 10 mL of brine. Then the solution was dried over anhydrous Na₂SO₄ and the solvent was evaporated in vacuum to give the desired compound.

3a, 97% Yield.

^1H NMR (CDCl₃, 400 MHz): δ 8.08 (d, $J=8.46$ Hz, 2H), 7.65 (d, $J=8.50$ Hz, 2H), 5.15 (s, 1H), 3.39 (brs, 1H), 3.24-3.17 (m, 1H), 3.10-3.03 (m, 1H), 2.89-2.85 (m, 4H), 2.75-2.65 (m, 2H), 2.65-2.16(m, 1H), 1.92-1.88 (m, 1H), 1.21 (s, 3H);

^1H NMR (CD₃OD, 400 MHz): δ 8.02 (d, $J=8.32$ Hz, 2H), 7.70 (d, $J=8.31$ Hz, 2H), 5.92 (d, $J=4.60$ Hz, 1H), 5.07 (d, $J=4.56$ Hz, 1H), 3.19-3.13 (m, 1H), 3.09-3.03 (m, 1H), 2.88 (brs, 4H), 2.71-2.67 (m, 2H), 1.94-1.90 (m, 1H), 1.79-1.73 (m, 1H), 1.73 (s, 3H);

^{13}C NMR (CD₃OD, 100 MHz): δ 171.02, 162.37, 149.67, 130.18, 129.33, 123.95, 77.50, 53.39, 26.84, 26.52, 26.24, 25.04, 23.94.

3b, 94% Yield.

^1H NMR (CDCl₃, 400 MHz): δ 8.07 (d, $J=8.41$ Hz, 2H), 7.67 (d, $J=8.41$ Hz, 2H), 5.21 (s, 1H), 3.46 (brs, 1H), 3.19-3.12 (m, 1H), 3.03-2.97 (m, 1H), 2.88-2.84 (m, 4H), 2.73-2.65

(m, 2H), 2.13-2.10(m, 1H), 1.86-1.77 (m, 2H), 1.24-1.17 (m, 1H), 1.02 (t, J= 7.41 Hz, 3H);

¹H NMR (CD₃OD, 400 MHz): δ 8.01 (d, J=8.52 Hz, 2H), 7.72 (d, J=8.39 Hz, 2H), 5.86 (d, J=4.62 Hz, 1H), 5.07 (d, J=4.63 Hz, 1H), 3.09-3.02 (m, 1H), 2.93-2.78 (m, 5H), 2.72-2.60 (m, 2H), 1.86-1.81 (m, 2H), 1.73-1.67 (m, 1H), 1.58-1.53 (m, 1H), 1.00 (t, J=7.36 Hz, 3H);

¹³C NMR (CD₃OD, 100 MHz): δ 171.04, 162.39, 149.95, 130.47, 129.19, 123.83, 76.88, 58.91, 29.05, 26.40, 26.23, 25.90, 24.81, 9.78.

3c, 97% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.07 (d, J=8.04 Hz, 2H), 7.67 (d, J=8.08 Hz, 2H), 5.20 (s, 1H), 3.49(brs, 1H), 3.19-3.13 (m, 1H), 3.03-2.97 (m, 1H), 2.87-2.82 (m, 4H), 2.71-2.63 (m, 2H), 2.13-2.10(m, 1H), 1.86-1.67 (m, 2H), 1.53-1.50 (m, 2H), 1.13-1.06 (m, 1H), 0.82 (t, J= 7.16 Hz, 3H);

¹H NMR (CD₃OD, 400 MHz): δ 8.02 (d, J=8.30 Hz, 2H), 7.72 (d, J=8.36 Hz, 2H), 5.85 (d, J=4.53 Hz, 1H), 5.09 (d, J=4.52 Hz, 1H), 3.11-3.06 (m, 1H), 2.97-2.80 (m, 5H), 2.78-2.65 (m, 2H), 1.87-1.70 (m, 3H), 1.52-1.41 (m, 3H), 0.81 (t, J= 7.35 Hz, 3H);

¹³C NMR (CD₃OD, 100 MHz): δ 171.04, 162.39, 149.93, 130.44, 129.21, 123.83, 76.88, 58.32, 38.48, 26.57, 26.23, 26.12, 26.06, 24.84, 18.14, 15.03.

3d, 93% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.06 (d, J=8.20 Hz, 2H), 7.66 (d, J=8.20 Hz, 2H), 5.19 (s, 1H), 3.49(brs, 1H), 3.19-3.12 (m, 1H), 3.02-2.96 (m, 1H), 2.86-2.81 (m, 4H), 2.71-2.62 (m, 2H), 2.13-2.09 (m, 1H), 1.85-1.70 (m, 2H), 1.52-1.47 (m, 2H), 1.22-1.08 (m, 3H), 0.84 (t, J= 7.16 Hz, 3H);

¹H NMR (CD₃OD, 400 MHz): δ 8.03 (d, J=8.23 Hz, 2H), 7.72 (d, J=8.38 Hz, 2H), 5.85 (d, J=4.57 Hz, 1H), 5.09 (d, J=4.60 Hz, 1H), 3.11-3.05 (m, 1H), 2.95-2.78 (m, 5H), 2.68-2.60 (m, 2H), 1.88-1.67 (m, 3H), 1.50-1.41 (m, 3H), 1.23-1.17 (m, 2H), 0.84 (t, J= 7.30 Hz, 3H);

¹³C NMR (CD₃OD, 100 MHz): δ 171.04, 162.39, 149.95, 130.45, 129.19, 123.83, 76.91, 58.29, 36.00, 26.94, 26.58, 26.23, 26.06, 24.85, 23.28, 14.65.

3e, 94% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.05 (d, J=8.10 Hz, 2H), 7.64 (d, J=8.15 Hz, 2H), 5.17 (s, 1H), 3.51(brs, 1H), 3.17-3.11 (m, 1H), 3.01-2.94 (m, 1H), 2.84-2.79 (m, 4H), 2.69-2.60 (m, 2H), 2.10-2.07 (m, 1H), 1.83-1.68 (m, 2H), 1.50-1.47 (m, 2H), 1.26-1.06 (m, 5H), 0.82 (t, J= 7.17 Hz, 3H);

¹H NMR (CD₃OD, 400 MHz): δ 8.06 (d, J=8.24 Hz, 2H), 7.72 (d, J=8.32 Hz, 2H), 5.84 (d, J=4.52 Hz, 1H), 5.10 (d, J=4.47 Hz, 1H), 3.12-3.05 (m, 1H), 2.96-2.84 (m, 5H), 2.70-2.58 (m, 2H), 1.89-1.67 (m, 3H), 1.55-1.40 (m, 3H), 1.27-1.14 (m, 4H), 0.83 (t, J= 7.06 Hz, 3H);

¹³C NMR (CD₃OD, 100 MHz): δ 171.01, 162.39, 149.93, 130.44, 129.19, 123.85, 76.90, 58.34, 36.20, 32.37, 26.59, 26.24, 25.81, 24.84, 24.37, 22.72, 14.58.

3f, 97% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.07 (d, $J=8.15$ Hz, 2H), 7.67 (d, $J=8.14$ Hz, 2H), 5.21 (s, 1H), 3.49(bris, 1H), 3.20-3.14 (m, 1H), 3.04-2.98 (m, 1H), 2.90-2.86 (m, 4H), 2.72-2.60 (m, 2H), 2.14-2.11 (m, 1H), 1.90-1.70 (m, 2H), 1.50-1.47 (m, 2H), 1.39-1.12 (m, 7H), 0.85 (t, $J=6.72$ Hz, 3H);

^1H NMR (CD_3OD , 400 MHz): δ 8.02 (d, $J=8.16$ Hz, 2H), 7.72 (d, $J=8.34$ Hz, 2H), 5.84 (d, $J=4.44$ Hz, 1H), 5.09 (d, $J=4.15$ Hz, 1H), 3.11-3.06 (m, 1H), 2.95-2.79 (m, 5H), 2.69-2.57 (m, 2H), 1.88-1.67 (m, 3H), 1.52-1.41 (m, 3H), 1.25-1.11 (m, 6H), 0.83 (t, $J=6.72$ Hz, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 171.01, 162.38, 149.94, 130.43, 129.19, 123.84, 76.90, 58.33, 36.27, 31.87, 29.80, 26.59, 26.23, 26.08, 25.81, 24.84, 24.66, 22.72, 14.59.

3g, 92% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.06 (d, $J=8.35$ Hz, 2H), 7.66 (d, $J=8.35$ Hz, 2H), 5.20 (s, 1H), 3.51(bris, 1H), 3.19-3.13 (m, 1H), 3.03-2.97 (m, 1H), 2.90-2.87 (m, 4H), 2.71-2.62 (m, 2H), 2.13-2.09 (m, 1H), 1.89-1.69 (m, 2H), 1.51-1.48 (m, 2H), 1.38-1.07 (m, 9H), 0.84 (t, $J=6.80$ Hz, 3H);

^1H NMR (CD_3OD , 400 MHz): δ 8.02 (d, $J=8.23$ Hz, 2H), 7.72 (d, $J=8.21$ Hz, 2H), 5.83 (d, $J=4.44$ Hz, 1H), 5.09 (d, $J=4.37$ Hz, 1H), 3.12-3.05 (m, 1H), 2.96-2.80 (m, 5H), 2.69-2.57 (m, 2H), 1.88-1.67 (m, 3H), 1.51-1.41 (m, 3H), 1.27-1.16 (m, 8H), 0.83 (t, $J=6.66$ Hz, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 170.99, 162.38, 149.92, 130.42, 129.18, 123.85, 79.84, 76.91, 58.33, 36.27, 31.89, 30.10, 29.31, 26.60, 26.23, 24.84, 24.69, 22.75, 14.61.

3h, 94% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.09 (d, $J=8.27$ Hz, 2H), 7.68 (d, $J=8.56$ Hz, 2H), 5.23 (s, 1H), 3.47(bris, 1H), 3.23-3.16 (m, 1H), 3.07-3.00 (m, 1H), 2.90-2.85 (m, 4H), 2.75-2.67 (m, 2H), 2.17-2.14 (m, 1H), 1.90-1.71 (m, 2H), 1.52-1.47 (m, 2H), 1.38-1.08 (m, 11H), 0.87 (t, $J=6.40$ Hz, 3H);

^1H NMR (CD_3OD , 400 MHz): δ 8.02 (d, $J=8.25$ Hz, 2H), 7.73 (d, $J=8.27$ Hz, 2H), 5.81 (d, $J=4.00$ Hz, 1H), 5.10 (d, $J=3.39$ Hz, 1H), 3.12-3.07 (m, 1H), 2.96-2.79 (m, 5H), 2.68-2.58 (m, 2H), 1.86-1.70 (m, 3H), 1.49-1.40 (m, 3H), 1.26-1.10 (m, 10H), 0.82 (t, $J=6.44$ Hz, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 170.96, 162.37, 149.90, 130.41, 129.17, 123.87, 79.84, 76.92, 58.33, 36.26, 31.95, 30.17, 29.61, 29.33, 26.63, 26.24, 24.85, 24.68, 22.79, 14.62.

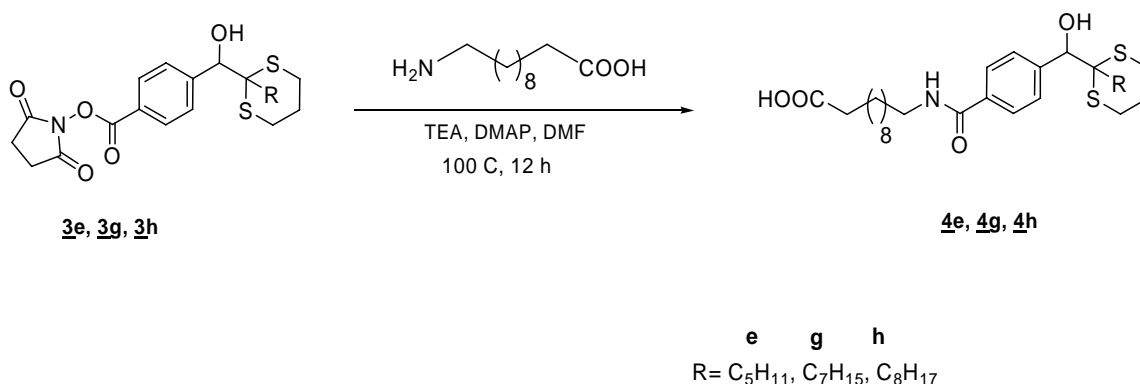
3i, 91% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.09 (d, $J=8.49$ Hz, 2H), 7.68 (d, $J=8.52$ Hz, 2H), 5.23 (s, 1H), 3.47(bris, 1H), 3.22-3.16 (m, 1H), 3.06-2.99 (m, 1H), 2.89-2.85 (m, 4H), 2.74-2.64 (m, 2H), 2.17-2.13 (m, 1H), 1.93-1.71 (m, 2H), 1.51-1.49 (m, 2H), 1.33-1.06 (m, 13H), 0.87 (t, $J=6.83$ Hz, 3H);

^1H NMR (CD_3OD , 400 MHz): δ 8.03 (d, $J=8.23$ Hz, 2H), 7.73 (d, $J=8.23$ Hz, 2H), 5.79 (bris, 1H), 5.10 (s, 1H), 3.12-3.07 (m, 1H), 2.96-2.80 (m, 5H), 2.68-2.56 (m, 2H), 1.87-1.68 (m, 3H), 1.49-1.40 (m, 3H), 1.32-1.12 (m, 12H), 0.83 (t, $J=6.51$ Hz, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 171.92, 162.36, 149.87, 130.39, 129.16, 123.90, 79.83, 76.93, 58.34, 36.29, 32.01, 30.20, 29.70, 29.67, 29.40, 26.65, 26.24, 24.85, 24.70, 22.82, 14.60.

4. General Procedure for syntheses Amino acid Based Compounds (4e, 4g and 4h):



To a mixture 11-aminoundecanoic acid (101 mg, 0.5 mmol) and 1-(4-[2-alkyl-1,3-dithian-2-yl](hydroxyl)methyl]benzoyloxy)pyrrolidine-2,5-dione (0.45 mmol) in DMF (10 mL) was added triethylamine (2 mL) and a catalytic amount of DMAP. The resulting solution was stirred at 100⁰ C for 12 h. This solution was poured onto crushed ice and acidified with 5% HCl solution. This mixture was extracted with ethyl acetate (100 mL) and the organic layer was washed with water, dried over anhyd.Na₂SO₄ and the solvent was evaporated to get the crude solid. The product was purified by column chromatography with 40-60% ethyl acetate in hexane to give the desired compound.

4e, 82% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 7.70 (d, J=8.41 Hz, 2H), 7.57(d, J=8.43 Hz, 2H), 6.19 (brt, J=5.71 Hz, 1H), 5.19 (s, 1H), 3.46 (q, J₁=6.68 Hz, J₂=13.45 Hz, 2H), 3.22-3.15 (m, 1H), 3.05-2.99 (m, 1H), 2.73-2.65 (m, 2H), 2.34 (t, J=7.46 Hz, 2H), 2.15-2.12 (m, 1H), 1.89-1.72 (m, 2H), 1.63-1.45 (m, 6H), 1.28-1.10 (m, 18H), 0.85 (t, J=7.18 Hz, 3H);

¹H NMR (CD₃OD, 400 MHz): δ 7.75 (d, J=8.20 Hz, 2H), 7.62(d, J=8.43 Hz, 2H), 5.14 (s, 1H), 3.37 (t, J= 7.16 Hz, 2H), 3.13-3.06 (m, 1H), 2.96-2.89 (m, 1H), 2.68-2.58 (m, 2H), 2.28 (t, J= 7.42 Hz, 2H), 2.00-1.94 (m, 1H), 1.87 -1.77 (m, 2H), 1.62-1.50 (m, 6H), 1.39-1.24 (m, 17H), 0.88 (t, J=7.20 Hz, 3H);

¹³C NMR (CD₃OD, 100 MHz): δ 176.50, 168.88, 143.90, 133.77, 128.97, 125.77, 76.11, 57.92, 39.90, 36.00, 33.81, 32.27, 29.46, 29.39, 29.34, 29.28, 29.25, 29.08, 26.95, 26.43, 25.62, 24.94, 24.48, 23.96, 22.41, 13.28.

4g, 85% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 7.71 (d, J=8.28 Hz, 2H), 7.58(d, J=8.15 Hz, 2H), 6.13 (brt, J=5.73 Hz, 1H), 5.20 (s, 1H), 3.46 (q, J₁=6.66 Hz, J₂=13.21 Hz, 2H), 3.22-3.16 (m, 1H), 3.06-3.00 (m, 1H), 2.74-2.65 (m, 2H), 2.35 (t, J=7.47 Hz, 2H), 2.16-2.12 (m, 1H), 1.91-1.86 (m, 1H), 1.79-1.73 (m, 1H), 1.63-1.49 (m, 6H), 1.38-1.14 (m, 22H), 0.86 (t, J=6.88 Hz, 3H);

¹H NMR (CD₃OD, 400 MHz): δ 7.74 (d, J=8.31 Hz, 2H), 7.62(d, J=8.44 Hz, 2H), 5.14 (s, 1H), 3.37 (t, J= 7.17 Hz, 2H), 3.13-3.07 (m, 1H), 2.96-2.90 (m, 1H), 2.68-2.60 (m, 2H),

2.28 (t, $J=7.42$ Hz, 2H), 2.00-1.96 (m, 1H), 1.85 -1.79 (m, 2H), 1.61-1.51 (m, 6H), 1.45-1.25 (m, 21H), 0.89 (t, $J=6.85$ Hz, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 176.50, 168.94, 143.93, 133.80, 128.96, 125.73, 76.17, 57.87, 39.86, 36.07, 33.77, 31.76, 29.94, 29.42, 29.34, 29.30, 29.21, 29.23, 29.07, 29.05, 26.90, 26.40, 25.61, 24.91, 24.46, 24.23, 22.50, 13.27.

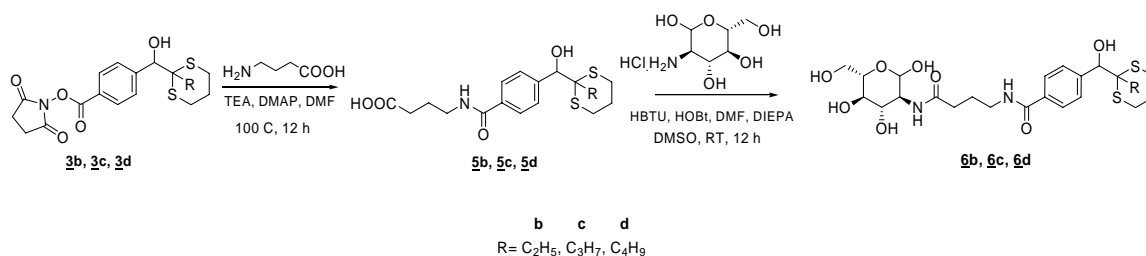
4h, 80% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 7.69 (d, $J=8.27$ Hz, 2H), 7.54(d, $J=8.34$ Hz, 2H), 6.31 (brt, $J=5.67$ Hz, 1H), 5.17 (s, 1H), 3.43 (q, $J_1=6.93$ Hz, $J_2=13.16$ Hz, 2H), 3.19-3.12 (m, 1H), 3.03-2.96 (m, 1H), 2.71-2.62 (m, 2H), 2.33 (t, $J=7.48$ Hz, 2H), 2.12-2.09 (m, 1H), 1.87-1.83 (m, 1H), 1.76-1.71 (m, 2H), 1.61-1.44 (m, 6H), 1.39-1.13 (m, 23H), 0.86 (t, $J=6.88$ Hz, 3H);

^1H NMR (CD_3OD , 400 MHz): δ 7.74 (d, $J=8.45$ Hz, 2H), 7.62(d, $J=8.25$ Hz, 2H), 5.14 (s, 1H), 3.37 (t, $J=7.19$ Hz, 2H), 3.14-3.07 (m, 1H), 2.97-2.90 (m, 1H), 2.67-2.59 (m, 2H), 2.28 (t, $J=7.43$ Hz, 2H), 1.99-1.96 (m, 1H), 1.85 -1.79 (m, 2H), 1.61-1.52 (m, 6H), 1.44-1.25 (m, 23H), 0.90 (t, $J=6.92$ Hz, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 176.53, 168.91, 143.92, 133.79, 128.96, 125.76, 76.15, 57.90, 39.87, 36.05, 33.80, 31.83, 29.98, 29.44, 29.37, 29.36, 29.32, 29.25, 29.22, 29.18, 29.06, 26.92, 26.42, 25.61, 24.92, 24.47, 24.22, 22.55, 13.31.

5. Procedure for syntheses Sugar Based Compounds (6b, 6c and 6d):



General procedure for the syntheses of 5b, 5c and 5d:

To a mixture of 4-aminobutyric acid (1.70 mmol) and 1-((4-[2-alkyl-1,3-dithian-2-yl](hydroxyl)methyl]benzoyl}oxy)pyrrolidine-2,5-dione (1.13 mmol) in DMF (15 mL) was added triethylamine (2 mL) and a catalytic amount of DMAP. The resulting solution was stirred at 100°C for 12 h. This mixture was poured onto crushed ice and acidified with 5% HCl solution. This mixture was extracted with ethyl acetate (100 mL) and the organic layer was washed with water, dried over Na_2SO_4 and the solvent was evaporated to get the desired compound.

5b, 91% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 7.70 (d, $J=8.44$ Hz, 2H), 7.55 (d, $J=8.26$ Hz, 2H), 6.80 (brt, $J=5.71$ Hz, 1H), 5.17 (s, 1H), 3.51 (q, $J_1=6.46$ Hz, $J_2=12.60$ Hz, 2H), 3.18-3.11 (m, 1H), 3.03-2.96 (m, 1H), 2.73-2.64 (m, 2H), 2.46 (t, $J=6.85$ Hz, 2H), 2.12-2.09 (m, 1H), 1.96-1.79 (m, 4H), 1.32-1.23 (m, 2H), 1.03 (t, $J=7.43$ Hz, 3H);

^1H NMR (CD_3OD , 400 MHz): δ 7.75 (d, $J=8.40$ Hz, 2H), 7.62 (d, $J=8.27$ Hz, 2H), 5.12 (s, 1H), 3.43 (t, $J=6.94$ Hz, 2H), 3.06-3.02 (m, 1H), 2.90-2.85 (m, 1H), 2.69-2.60 (m, 2H), 2.40 (t, $J=7.35$ Hz, 2H), 1.95-1.87 (m, 4H), 1.79-1.75 (m, 1H), 1.54-1.49 (m, 1H), 1.05 (t, $J=7.40$ Hz, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 175.88, 169.04, 143.98, 133.58, 129.03, 125.81, 76.08, 58.55, 39.29, 31.26, 28.70, 26.26, 25.45, 24.70, 24.42, 8.37.

5c, 95% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 7.70 (d, $J=8.14$ Hz, 2H), 7.49 (d, $J=8.16$ Hz, 2H), 7.15 (brt, $J=5.25$ Hz, 1H), 5.11 (s, 1H), 3.40 (q, $J_1=5.95$ Hz, $J_2=12.04$ Hz, 2H), 3.13-3.06 (m, 1H), 2.96-2.90 (m, 1H), 2.66-2.53 (m, 2H), 2.38 (t, $J=6.79$ Hz, 2H), 2.10-1.97 (m, 1H), 1.86-1.67 (m, 4H), 1.54-1.39 (m, 2H), 1.22-1.13 (m, 2H), 0.85 (t, $J=7.23$ Hz, 3H);

^1H NMR (CD_3OD , 400 MHz): δ 7.75 (d, $J=8.39$ Hz, 2H), 7.62 (d, $J=8.28$ Hz, 2H), 5.13 (s, 1H), 3.43 (t, $J=6.94$ Hz, 2H), 3.12-3.05 (m, 1H), 2.95-2.89 (m, 1H), 2.67-2.59 (m, 2H), 2.40 (t, $J=7.35$ Hz, 2H), 2.00-1.76 (m, 5H), 1.62-1.53 (m, 2H), 1.42-1.34 (m, 1H), 1.27 (t, $J=7.31$ Hz, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 175.89, 169.07, 143.97, 133.62, 129.01, 125.82, 76.08, 57.90, 39.28, 38.27, 31.26, 26.41, 25.60, 24.70, 24.45, 17.67, 13.70.

5d, 97% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 7.76 (d, $J=8.20$ Hz, 2H), 7.55 (d, $J=8.26$ Hz, 2H), 7.10 (brt, $J=5.42$ Hz, 1H), 5.12 (s, 1H), 3.42 (q, $J_1=5.90$ Hz, $J_2=12.50$ Hz, 2H), 3.13-3.04 (m, 1H), 2.97-2.91 (m, 1H), 2.67-2.56 (m, 2H), 2.39 (t, $J=6.76$ Hz, 2H), 2.07-1.98 (m, 1H), 1.86-1.66 (m, 4H), 1.54-1.38 (m, 2H), 1.28-1.08 (m, 4H), 0.82 (t, $J=7.21$ Hz, 3H);

^1H NMR (CD_3OD , 400 MHz): δ 7.75 (d, $J=8.41$ Hz, 2H), 7.62 (d, $J=8.35$ Hz, 2H), 5.14 (s, 1H), 3.43 (t, $J=6.96$ Hz, 2H), 3.12-3.05 (m, 1H), 2.96-2.89 (m, 1H), 2.68-2.58 (m, 2H), 2.40 (t, $J=7.36$ Hz, 2H), 1.98-1.75 (m, 5H), 1.61-1.48 (m, 2H), 1.45-1.37 (m, 1H), 1.27-1.18 (m, 2H), 0.88 (t, $J=7.34$ Hz, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 175.87, 169.04, 143.96, 133.60, 129.02, 125.82, 76.05, 57.91, 39.29, 35.74, 31.26, 26.53, 26.44, 25.62, 24.70, 24.48, 23.10, 13.29.

General procedure for the syntheses of 6b, 6c and 6d:

To a mixture of **5a** (190 mg, 0.49 mmol), HBTU (206 mg, 0.54 mmol), and HOBt (73 mg, 0.54 mmol) in DMF (10 mL) was added DIPEA (0.2 mL, 1.08 mmol). The reaction mixture was then stirred for 5 min at ambient temperature. D-glucosamine hydrochloride (117 mg, 0.54 mmol) was dissolved in 1 mL DMSO, added to the above solution and stirred at room temperature for 12 h. The reaction mixture was poured into cold ether and allowed to settle down. The ether layer was decanted off and the brownish yellow material was washed with cold ether several times before drying. The product was

purified by column chromatography using an eluent of 5% methanol in methylene chloride to give the desired compound.

6b, 65% Yield.

¹H NMR (CD₃OD, 400 MHz): δ 7.77 (d, J=8.46 Hz, 2H), 7.64 (d, J=8.36 Hz, 2H), 5.12 (s, 1H), 5.10 (d, J=3.45 Hz, α-anomer), 4.61 (d, J=8.4 Hz, β-anomer), 3.89-3.65 (m, 5H), 3.47-3.32 (m, 3H), 3.11-3.04 (m, 1H), 2.94-2.87 (m, 1H), 2.71-2.61 (m, 2H), 2.36-2.32 (m, 2H), 2.00-1.87 (m, 4H), 1.83-1.74 (m, 1H), 1.58-1.49 (m, 1H), 1.39-1.27 (m, 1H), 1.06 (t, J=7.41 Hz, 3H);

¹³C NMR (CD₃OD, 100 MHz): δ 174.85, 169.00, 144.09, 133.42, 129.03, 125.87, 91.42, 76.07, 71.92, 71.53, 71.26, 61.59, 58.53, 54.67, 39.18, 33.06, 28.68, 26.25, 25.56, 25.45, 24.42, 8.35.

6c, 62% Yield.

¹H NMR (CD₃OD, 400 MHz): δ 7.78 (d, J=8.40 Hz, 2H), 7.63 (d, J=8.32 Hz, 2H), 5.14 (s, 1H), 5.11 (d, J=3.40 Hz, α-anomer), 4.62 (d, J=8.36 Hz, β-anomer), 3.86-3.63 (m, 5H), 3.48-3.32 (m, 3H), 3.14-3.07 (m, 1H), 2.97-2.90 (m, 1H), 2.70-2.60 (m, 2H), 2.37-2.33 (m, 2H), 2.00-1.88 (m, 3H), 1.85-1.78 (m, 2H), 1.64-1.51 (m, 2H), 1.38-1.32 (m, 2H), 0.86 (t, J=7.32 Hz, 3H);

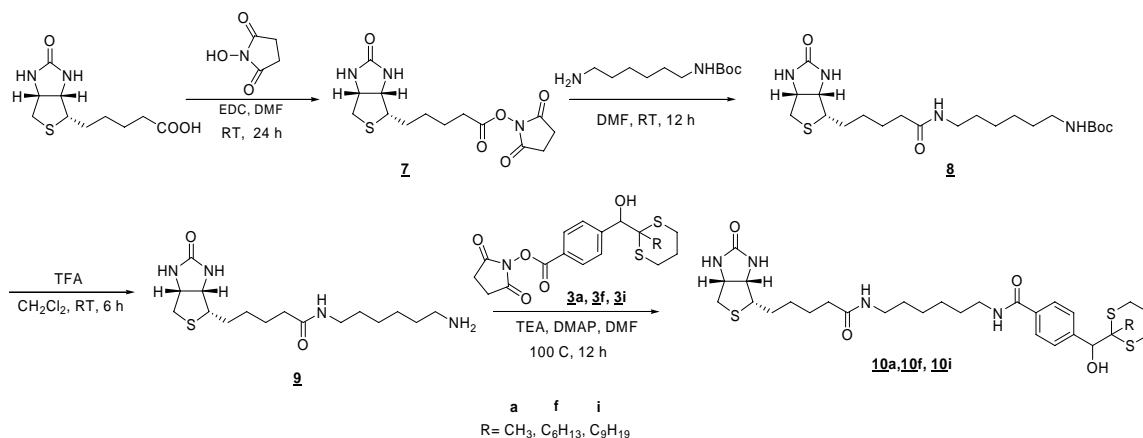
¹³C NMR (CD₃OD, 100 MHz): δ 169.06, 144.08, 133.50, 128.98, 125.83, 125.81, 91.40, 76.12, 71.91, 71.50, 71.28, 61.60, 57.83, 54.68, 39.11, 38.30, 33.03, 28.69, 26.38, 25.57, 24.45, 17.62, 13.62.

6d, 56% Yield.

¹H NMR (CD₃OD, 400 MHz): δ 7.77 (d, J=8.45 Hz, 2H), 7.63 (d, J=8.30 Hz, 2H), 5.14 (s, 1H), 5.11 (d, J=3.41 Hz, α-anomer), 4.61 (d, J=8.31 Hz, β-anomer), 3.84-3.61 (m, 5H), 3.45-3.35 (m, 3H), 3.14-3.05 (m, 1H), 2.97-2.90 (m, 1H), 2.69-2.58 (m, 2H), 2.36-2.32 (m, 2H), 2.00-1.88 (m, 5H), 1.59-1.48 (m, 2H), 1.38-1.34 (m, 2H), 1.29-1.18 (m, 2H), 0.89 (t, J=7.33 Hz, 3H);

¹³C NMR (CD₃OD, 100 MHz): δ 174.74, 169.04, 144.04, 133.57, 128.98, 125.79, 91.40, 76.13, 71.92, 71.46, 71.31, 61.63, 57.83, 54.71, 51.51, 39.12, 35.78, 33.13, 26.49, 26.39, 25.59, 24.46, 23.06, 17.58, 13.18.

6. Procedure for syntheses Biotin Based Compounds (10a, 10f and 10i)



Preparation of 7:

A mixture of biotin (1.0 g, 4.09 mmol), N-hydroxysuccinimide (753 mg, 6.54 mmol), and EDC (1.02 g, 5.32 mmol) was dissolved in DMF (40 mL) and stirred for 24 h at ambient temperature. The solution was poured onto crushed ice and the solid obtained was filtered, washed with water and, dried to give **7**.

7, 95% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 6.40 (brs, 1H), 6.34 (brs, 1H), 4.30-4.26 (m, 1H), 4.16-4.12 (m, 1H), 2.84-2.76 (m, 6H), 2.67-2.62 (m, 2H), 2.58 (d, 1H), 1.66-1.57 (m, 3H), 1.52-1.36 (m, 3H),

¹³C NMR (DMSO-d₆, 100 MHz): δ 170.95, 169.61, 163.35, 61.66, 59.83, 55.91, 30.66, 28.50, 28.25, 26.12, 24.98

Preparation of 8:

A mixture of **7** (500 mg, 1.46 mmol) and N-boc-1,6-diaminohexane (411 mg, 1.90 mmole) in DMF (20 mL) was stirred for 12 h at ambient temperature. The reaction mixture was poured onto crushed ice, the solid was collected by vacuum filtration, washed with water and dried to give pure **8**.

8, 96% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 7.71 (brt, J=5.36 Hz, 1H), 6.73 (brt, J=5.56 Hz, 1H), 6.39 (s, 1H), 6.33 (s, 1H), 4.29-4.26 (m, 1H), 4.11-4.09 (m, 1H), 3.09-3.04 (m, 1H), 3.01 (q, J₁=6.65 Hz, J₂=13.06 Hz, 2H), 2.88-2.77 (m, 3H), 2.57 (d, J=12.32 Hz, 1H), 2.03 (t, J=7.41 Hz, 2H), 1.62-1.20 (m, 23H);

^1H NMR (CD_3OD , 400 MHz): δ 4.50-4.47 (m, 1H), 4.31-4.28 (m, 1H), 3.21-3.13 (m, 3H), 3.03 (t, $J=6.98$ Hz, 2H), 2.94 (dd, $J_1=4.96$ Hz, $J_2=12.74$ Hz, 1H), 2.71 (d, 12.74 Hz, 1H), 2.20 (t, $J=7.39$ Hz, 2H), 1.75-1.54 (m, 4H), 1.49-1.42 (m, 15H), 1.34-1.32 (m, 4H); ^{13}C NMR (CD_3OD , 100 MHz): δ 174.75, 164.91, 157.37, 78.59, 62.20, 60.43, 55.84, 40.05, 39.87, 39.09, 35.64, 29.72, 29.18, 28.61, 28.33, 27.63, 26.47, 26.33, 25.77.

Preparation of 9:

8 (500 mg, 1.45 mmol) was dissolved in a mixture of CH_2Cl_2 (5 mL) and CF_3COOH (2 mL) to be stirred at room temperature for 6 h. The solvents were evaporated to dryness to give pure **9**.

9, 95% Yield.

^1H NMR (DMSO-d_6 , 400 MHz): δ 7.75 (t, $J=5.58$ Hz, 1H), 7.63 (brs, 2H), 6.41 (brs, 2H), 4.30-4.27 (m, 1H), 4.12-4.09 (m, 1H), 3.09-3.04 (m, 1H), 3.02 (q, $J_1=6.65$ Hz, $J_2=12.92$ Hz, 2H), 2.82-2.71 (m, 3H), 2.57 (d, $J=12.57$ Hz, 1H), 2.04 (t, $J=7.29$ Hz, 2H), 1.63-1.22 (m, 14H); ^{13}C NMR (DMSO-d_6 , 100 MHz): δ 172.51, 163.41, 61.73, 59.87, 56.13, 39.45, 38.88, 35.88, 29.68, 28.91, 28.73, 27.64, 26.57, 26.16, 26.04.

General procedure for the syntheses of 10a,10f and 10i:

To a mixture of **9** (100 mg, 0.29 mmol) and 1-(4-[2-alkyl-1,3-dithian-2-yl](hydroxyl)methyl)benzoyl}oxy)pyrrolidine-2,5-dione (0.22 mmol) in DMF (10 mL) was added triethylamine (1 mL) and a catalytic amount of DMAP. The resulting solution was stirred at 100°C for 12 h. The solvent was removed under vacuo and the residue was dissolved in ethyl acetate (100 mL). The organic layer was washed with water, dried over Na_2SO_4 and the solvent was evaporated to obtain a brownish solid. The crude product was purified by column chromatography using 10% methanol in ethyl acetate as eluent to give the desired compound.

10a, 86% Yield.

^1H NMR (CD_3OD , 400 MHz): δ 7.75 (d, $J=8.34$ Hz, 2H), 7.58 (d, $J=8.45$ Hz, 2H), 5.10 (s, 1H), 4.47-4.44 (m, 1H), 4.28-4.25 (m, 1H), 3.38 (t, $J=7.11$ Hz, 2H), 3.21-2.98 (m, 6H), 2.92-2.85 (m, 2H), 2.72-2.66 (m, 3H), 2.20 (t, $J=7.37$ Hz, 2H), 2.04-2.02 (m, 1H), 1.87-1.84 (m, 1H), 1.72-1.33 (m, 12H), 1.28 (s, 3H); ^{13}C NMR (CD_3OD , 100 MHz): δ 174.77, 168.88, 164.62, 143.71, 133.83, 128.72, 125.81, 76.56, 62.19, 60.42, 55.84, 52.82, 39.87, 39.69, 39.04, 35.65, 29.27, 29.16, 28.60, 28.33, 26.54, 26.51, 26.45, 26.00, 25.78, 24.62, 22.56.

10f, 82% Yield.

^1H NMR (CD_3OD , 400 MHz): δ 7.75 (d, $J=8.27$ Hz, 2H), 7.62 (d, $J=8.30$ Hz, 2H), 5.14 (s, 1H), 4.47-4.44 (m, 1H), 4.29-4.26 (m, 1H), 3.38 (t, $J=7.08$ Hz, 2H), 3.20-3.08 (m, 4H), 2.94-2.87 (m, 2H), 2.69-2.61 (m, 3H), 2.20 (t, $J=7.27$ Hz, 2H), 1.98-1.25 (m, 26H), 0.89 (t, $J=6.90$ Hz, 3H);

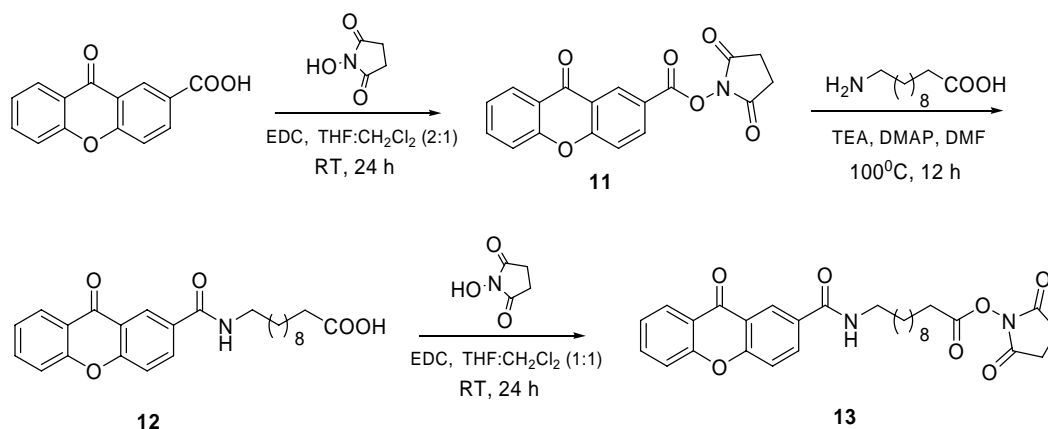
^{13}C NMR (CD_3OD , 100 MHz): δ 174.78, 168.94, 164.90, 143.97, 133.77, 128.97, 125.73, 76.16, 75.10, 62.19, 60.41, 57.85, 55.83, 39.85, 39.68, 39.03, 35.63, 36.05, 31.65, 29.66, 29.25, 29.15, 28.59, 28.32, 26.51, 26.44, 26.39, 25.76, 25.59, 24.47, 24.20, 22.45, 13.21.

10i, 76% Yield.

^1H NMR (CD_3OD , 400 MHz): δ 7.75 (d, $J=8.18$ Hz, 2H), 7.62 (d, $J=8.21$ Hz, 2H), 5.14 (s, 1H), 4.47-4.44 (m, 1H), 4.29-4.26 (m, 1H), 3.38 (t, $J=6.98$ Hz, 2H), 3.18-3.08 (m, 4H), 2.98-2.87 (m, 2H), 2.69-2.61 (m, 3H), 2.20 (t, $J=7.26$ Hz, 2H), 1.97-1.26 (m, 32H), 0.90 (t, $J=6.76$ Hz, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 174.75, 168.88, 164.88, 143.95, 133.75, 128.98, 125.76, 76.12, 62.19, 60.42, 57.92, 55.85, 39.89, 39.71, 39.06, 36.02, 35.66, 31.88, 29.98, 29.46, 29.40, 29.28, 29.25, 29.17, 28.62, 28.34, 26.54, 26.47, 26.42, 25.79, 25.62, 24.48, 24.23, 22.57, 13.33.

7. Procedure for synthesis of ET-Sensitizer (13):



Preparation of 11:

A mixture of 9-oxo-9H-xanthene-2-carboxylic acid (300 mg, 1.25 mmol), N-hydroxysuccinimide (230 mg, 2 mmol) and EDC (287 mg, 1.55 mmol) was dissolved in THF:CH₂Cl₂ (2:1, 30 mL) and stirred for 24 h at room temperature. The solution was washed with 20 mL water and 20 mL of saturated NaHCO₃ followed by 10 mL of brine. The organic layer was dried over anhydrous Na₂SO₄ and the solvent was evaporated in vacuum to give the desired compound.

11, 96% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 9.17 (d, $J=2.05$ Hz, 1H), 8.43 (dd, $J_1=2.25$ Hz, $J_2=8.84$ Hz, 1H), 8.36 (dd, $J_1=1.70$ Hz, $J_2=8.18$ Hz, 1H), 7.81-7.77 (m, 1H), 7.63 (d, $J=8.82$ Hz, 1H), 7.56 (d, $J=7.84$ Hz, 1H), 7.47-7.43 (m, 1H), 2.93 (s, 4H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 173.02, 169.46, 160.96, 159.78, 155.94, 135.92, 135.88, 131.02, 126.98, 125.17, 121.79, 121.75, 121.00, 119.39, 118.36, 25.94.

Preparation of 12:

To a mixture 11-aminoundecanoic acid (71 mg, 0.35 mmol) and 1-[[9-oxo-9H-xanthen-2-yl)carbonyl]oxy}pyrrolidine-2,5-dione (**11**, 100 mg, 0.29 mmol) in DMF (10 mL) was added triethylamine (2 mL) and a catalytic amount of DMAP. The resulting solution was stirred at 100^o C for 12 h, then poured onto crushed ice and acidified with 5% HCl solution, the solid was obtained by vacuum filtration, washed with water and dried. The crude product was purified by crystallization from methanol.

12, 75% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 8.77 (brt, J=5.43 Hz, 1H), 8.69 (d, J=2.20 Hz, 1H), 8.30 (dd, J₁=2.27 Hz, J₂=8.80 Hz, 1H), 8.21 (dd, J₁=1.56 Hz, J₂=7.93 Hz, 1H), 7.91-7.87 (m, 1H), 7.74 (dd, J₁=8.59 Hz, J₂=18.43 Hz, 2H), 7.51-7.48 (m, 1H), 3.27 (q, J₁=6.72 Hz, J₂=12.81 Hz, 2H), 2.16 (t, J=7.36 Hz, 2H), 1.52-1.44 (m, 4H), 1.24-1.16 (m, 12H);

¹³C NMR (DMSO-d₆, 100 MHz): δ 176.56, 175.14, 165.18, 157.65, 156.15, 136.43, 134.81, 131.13, 126.71, 125.88, 125.34, 121.75, 121.23, 119.01, 118.90, 34.32, 29.70, 29.66, 29.58, 29.47, 29.44, 29.24, 27.21, 25.17.

Preparation of 13:

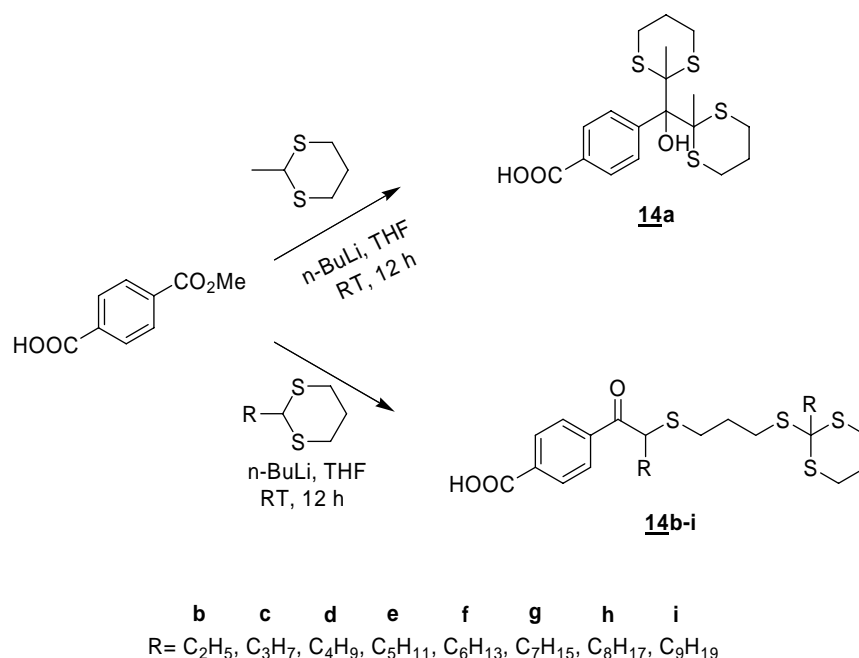
A mixture of **12** (200 mg, 1.22 mmol), N-hydroxysuccinimide (87 mg, 0.75 mmol) and EDC (113 mg, 0.59 mmol) was dissolved in THF:CH₂Cl₂ (1:1, 20 mL) and stirred for 24 h at room temperature. The solution was washed with 20 mL of water, 20 mL of saturated NaHCO₃, and 10 mL of brine. The solution was dried over anhydrous Na₂SO₄ and evaporated in vacuum to give the crude product which was purified by column chromatography using 60% ethyl acetate-hexane as eluent to give the pure compound.

13, 85% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 8.77 (brt, J= 5.42 Hz, 1H), 8.69 (d, J= 2.21 Hz, 1H), 8.30 (dd, J₁=2.27 Hz, J₂= 8.79 Hz, 1H), 8.21 (dd, J₁=1.60 Hz, J₂= 7.93 Hz, 1H), 7.91-7.87 (m, 1H), 7.73 (dd, J₁=8.63 Hz, J₂= 17.64 Hz, 2H), 7.51-7.47 (m, 1H), 3.28 (q, J₁= 5.86 Hz, J₂=11.94 Hz, 2H), 2.78 (s, 4H), 2.63 (t, J= 7.20 Hz, 2H), 1.59-1.51 (m, 4H), 1.38-1.24 (m, 12H);

¹³C NMR (DMSO-d₆, 100 MHz): δ 176.63, 170.91, 169.64, 165.22, 157.70, 156.21, 144.93, 136.52, 134.85, 131.17, 126.75, 125.89, 125.42, 121.79, 121.28, 119.09, 118.97, 30.86, 29.69, 29.57, 29.48, 29.43, 29.18, 28.68, 27.19, 26.11, 24.97.

8. General procedure for syntheses of 14(a-i)



n-BuLi (8.96 mL, 14.3 mmol, 1.6 M solution in THF) was added at 20⁰ C to a mixture of 2-alkyl-1,3-dithiane (14-17 mmol) in 50 mL of dry THF. The resulting solution was stirred at this temperature for 15 min. Monomethylterephthalate (516 mg, 2.86 mmol) in THF (30 mL) was added to the generated dithiane anion and the solution was stirred overnight. Aqueous work-up included quenching with saturated NH₄Cl (20 mL) followed by extraction with ethyl acetate (3 X 50 mL). The organic layer was dried over Na₂SO₄ and the solvent was removed in vacuum. The crude product was purified by chromatography on a slurry-packed silica gel column using 10% EtOAc-hexane as eluent.

14a, 85% Yield.

¹H NMR (DMSO-d₆, 400 MHz): δ 8.52 (d, J= 8.58 Hz, 1H), 7.80 (s, 2H), 7.74 (d, J=8.49 Hz, 1H), 5.29 (brs, 1H), 2.84-2.77 (m, 2H), 2.68-2.63 (m, 2H), 2.59-2.53 (m, 2H), 2.26-2.20 (m, 2H), 2.04 (s, 6H), 1.79-1.72 (m, 2H), 1.59-1.49 (m, 2H);

¹³C NMR (DMSO-d₆, 100 MHz): δ 168.10, 146.65, 131.26, 130.62, 129.92, 127.47, 126.46, 86.95, 63.29, 28.85, 27.97, 26.48, 24.51.

14b, 82% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.21 (d, J= 8.58 Hz, 2H), 8.62 (d, J=8.62 Hz, 2H), 4.05 (t, J=7.30 Hz, 1H), 3.28-3.20 (m, 2H), 2.63-2.57 (m, 3H), 2.51-2.44 (m, 3H), 2.13-2.05 (m, 2H), 1.99-1.90 (m, 3H), 1.82-1.73 (m, 3H), 1.11 (t, J=7.38 Hz, 3H), 1.06 (t, J=7.33 Hz, 3H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.85, 170.59, 140.58, 132.97, 130.66, 128.74, 63.58, 49.35, 36.07, 31.87, 28.89, 28.19, 27.53, 25.29, 23.34, 14.60, 12.24, 9.07.

14c, 83% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.21 (d, J = 8.70 Hz, 2H), 8.08 (d, J =8.75 Hz, 2H), 4.12 (t, J =7.38 Hz, 1H), 3.28-3.20 (m, 2H), 2.64-2.42 (m, 6H), 2.10-2.01 (m, 2H), 1.91-1.73 (m, 6H), 1.66-1.59 (m, 2H), 1.54-1.38 (m, 2H), 0.97 (t, J =7.36 Hz, 3H), 0.92 (t, J =7.34 Hz, 3H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.76, 171.42, 140.49, 132.98, 130.62, 128.72, 62.77, 47.19, 45.34, 32.12, 31.96, 28.90, 28.23, 27.58, 27.56, 25.27, 20.84, 17.81, 14.30, 14.17.

14d, 86% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.20 (d, J = 8.68 Hz, 2H), 8.08 (d, J =8.75 Hz, 2H), 4.12 (t, J =7.38 Hz, 1H), 3.29-3.21 (m, 2H), 2.64-2.42 (m, 6H), 2.12-2.04 (m, 2H), 1.94-1.90 (m, 2H), 1.85-1.75 (m, 4H), 1.63-1.55 (m, 2H), 1.40-1.29 (m, 6H), 0.93-0.89 (m, 6H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.83, 171.45, 140.48, 133.17, 130.63, 128.72, 62.82, 47.47, 42.91, 31.97, 29.86, 29.82, 28.87, 28.25, 27.58, 26.47, 25.29, 22.92, 22.76, 14.21, 14.20, 14.15.

14e, 85% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.21 (d, J = 8.67 Hz, 2H), 8.08 (d, J =8.70 Hz, 2H), 4.12 (t, J =7.33 Hz, 1H), 3.29-3.20 (m, 2H), 2.60-2.42 (m, 6H), 2.10-2.04 (m, 2H), 1.93-1.75 (m, 6H), 1.64-1.57 (m, 2H), 1.38-1.21 (m, 10H), 0.90 (t, J =7.07 Hz, 6H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.83, 171.57, 140.57, 133.00, 130.66, 128.73, 62.87, 47.52, 43.15, 31.98, 31.95, 31.81, 30.11, 28.90, 28.27, 27.60, 27.59, 27.35, 25.29, 24.02, 22.72, 22.69, 14.26, 14.25.

14f, 81% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.20 (d, J = 8.66 Hz, 2H), 8.08 (d, J =8.72 Hz, 2H), 4.12 (t, J =7.33 Hz, 1H), 3.29-3.20 (m, 2H), 2.64-2.49 (m, 6H), 2.09-2.05 (m, 2H), 1.94-1.80 (m, 6H), 1.64-1.57 (m, 2H), 1.38-1.25 (m, 14H), 0.89 (t, J =6.81 Hz, 6H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.84, 171.10, 140.58, 132.95, 130.66, 128.73, 62.87, 47.54, 43.20, 31.98, 31.86, 31.80, 30.18, 29.45, 29.31, 28.90, 28.28, 27.64, 27.60, 25.29, 24.29, 22.79, 22.72, 14.29, 14.22.

14g, 88% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.21 (d, J = 8.27 Hz, 2H), 8.09 (d, J =8.40 Hz, 2H), 4.12 (t, J =7.33 Hz, 1H), 3.29-3.21 (m, 2H), 2.66-2.42 (m, 6H), 2.11-2.03 (m, 2H), 1.94-1.74 (m, 6H), 1.64-1.56 (m, 2H), 1.48-1.27 (m, 18H), 0.89 (t, J =6.79 Hz, 6H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.83, 171.56, 140.59, 132.97, 130.65, 128.73, 62.87, 47.53, 43.19, 33.21, 31.99, 31.97, 30.16, 29.75, 29.61, 29.59, 29.35, 29.31, 28.89, 28.27, 27.68, 27.59, 25.29, 24.34, 23.65, 22.87, 22.85, 14.33.

14h, 87% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.21 (d, J = 8.16 Hz, 2H), 8.08 (d, J =8.28 Hz, 2H), 4.12 (t, J =7.34 Hz, 1H), 3.28-3.20 (m, 2H), 2.62-2.44 (m, 6H), 2.10-2.02 (m, 2H), 1.93-1.73 (m, 6H), 1.64-1.54 (m, 2H), 1.39-1.17 (m, 22H), 0.88 (t, J =6.77 Hz, 6H);

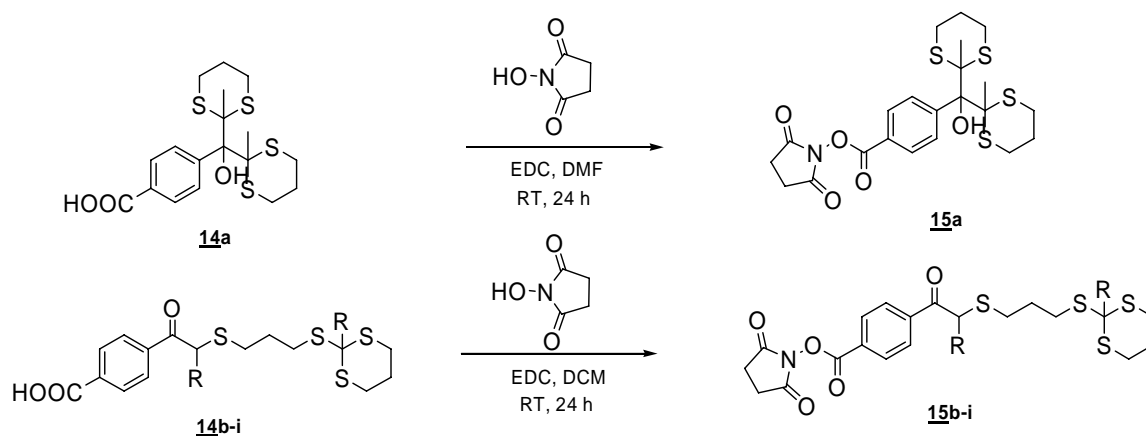
^{13}C NMR (CDCl_3 , 100 MHz): δ 194.81, 171.35, 140.52, 133.06, 130.61, 128.71, 62.87, 47.53, 43.18, 32.07, 32.05, 31.96, 31.80, 30.16, 29.79, 29.65, 29.63, 29.59, 29.45, 29.43, 28.90, 28.26, 27.66, 27.59, 25.29, 24.32, 22.87, 14.36.

14i, 82% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.20 (d, J = 8.21 Hz, 2H), 8.08 (d, J =8.29 Hz, 2H), 4.12 (t, J =7.27 Hz, 1H), 3.29-3.21 (m, 2H), 2.64-2.42 (m, 6H), 2.12-2.03 (m, 2H), 1.93-1.78 (m, 6H), 1.64-1.57 (m, 2H), 1.37-1.22 (m, 26H), 0.89 (t, J =6.84 Hz, 6H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.84, 171.49, 140.61, 132.95, 130.66, 128.73, 62.88, 47.57, 43.21, 32.11, 32.09, 31.98, 30.19, 29.80, 29.76, 29.73, 29.68, 29.65, 29.53, 29.51, 28.91, 28.30, 27.68, 27.60, 25.30, 24.34, 22.91, 22.90, 14.35, 14.34.

9. General procedure for syntheses of 15(a-i)



b c d e f g h i
 R= C₂H₅, C₃H₇, C₄H₉, C₅H₁₁, C₆H₁₃, C₇H₁₅, C₈H₁₇, C₉H₁₉

Preparation of 15a:

A mixture of **14a** (900 mg, 2.16 mmol), N-hydroxysuccinimide (398 mg, 3.46 mmol) and EDC (539 mg, 2.81 mmol) was dissolved in DMF (30 mL) and stirred for 24 h at room temperature. The solution was poured into crushed ice and the solid was obtained by vacuum filtration, washed with water and dried to give pure **15a**.

15a, 96% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.36 (dd, J₁= 1.90 Hz, J₂=8.53 Hz, 1H), 8.12 (dq, J₁= 1.94 Hz, J₂=8.44 Hz, 2H), 8.04 (dd, J₁= 1.94 Hz, J₂=8.52 Hz, 1H), 4.50 (s, 1H), 2.90-2.80 (m, 8H), 2.75-2.70 (m, 4H), 2.16 (s, 6H), 1.96-1.78 (m, 4H);

¹³C NMR (CDCl₃, 100 MHz): δ 169.53, 161.92, 147.43, 130.52, 130.08, 129.46, 127.94, 124.45, 86.41, 63.41, 28.75, 27.94, 27.77, 25.92, 24.02.

Preparation of 15 (b-i):

A mixture **14b** (2.95 mmol), N-hydroxysuccinimide (4.72 mmol) and EDC (3.83 mmol) was dissolved in CH₂Cl₂ (30 mL) and stirred for 24 h at room temperature. The solution was washed with 20 mL water, 20 mL of saturated NaHCO₃, followed by 10 mL of brine. Then the solution was dried over anhydrous Na₂SO₄ and the solvent was evaporated in vacuum to give the desired compound.

15b, 92% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.23 (d, J= 8.74 Hz, 2H), 8.11 (d, J= 8.44 Hz, 2H), 4.02 (t, J=7.36 Hz, 1H), 3.27-3.19 (m, 2H), 2.92 (brs, 4H), 2.62-2.38 (m, 6H), 2.12-2.05 (m, 2H), 2.00-1.74 (m, 6H), 1.12 (t, J=7.38 Hz, 3H), 1.06 (t, J=7.33 Hz, 3H);

15c, 94% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.23 (d, J= 8.75 Hz, 2H), 8.11 (d, J= 8.77 Hz, 2H), 4.11 (t, J=7.38 Hz, 1H), 3.28-3.20 (m, 2H), 2.92 (brs, 4H), 2.63-2.40 (m, 6H), 2.11-2.00 (m, 2H), 1.92-1.73 (m, 6H), 1.68-1.58 (m, 2H), 1.54-1.38 (m, 2H), 0.98 (t, J=7.36 Hz, 3H), 0.93 (t, J=7.35 Hz, 3H);

¹³C NMR (CDCl₃, 100 MHz): δ 194.33, 169.37, 161.35, 141.31, 130.93, 128.95, 128.69, 62.76, 47.29, 45.34, 31.98, 31.95, 28.87, 28.20, 27.55, 25.92, 25.23, 20.77, 17.80, 14.28, 14.12.

15d, 93% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.22 (d, J= 8.74 Hz, 2H), 8.10 (d, J= 8.77 Hz, 2H), 4.09 (t, J=7.35 Hz, 1H), 3.28-3.19 (m, 2H), 2.92 (brs, 4H), 2.61-2.44 (m, 6H), 2.10-2.02 (m, 2H), 1.95-1.87 (m, 2H), 1.85-1.72 (m, 4H), 1.62-1.54 (m, 2H), 1.38-1.24 (m, 6H), 0.92-0.88 (m, 6H);

¹³C NMR (CDCl₃, 100 MHz): δ 194.36, 169.25, 161.35, 141.34, 130.98, 128.95, 128.74, 62.88, 47.61, 42.93, 31.97, 29.77, 29.74, 28.87, 28.23, 27.60, 26.47, 25.91, 25.27, 22.91, 22.73, 14.19.

15e, 97% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.23 (d, J= 8.33 Hz, 2H), 8.10 (d, J= 8.36 Hz, 2H), 4.09 (t, J=7.37 Hz, 1H), 3.28-3.20 (m, 2H), 2.92 (brs, 4H), 2.60-2.45 (m, 6H), 2.11-2.01 (m, 2H), 1.94-1.90 (m, 2H), 1.86-1.73 (m, 4H), 1.65-1.56 (m, 2H), 1.38-1.22 (m, 10H), 0.90(t, J=7.05 Hz, 6H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.39, 169.30, 161.36, 141.36, 130.97, 128.95, 128.73, 62.87, 47.65, 43.14, 31.97, 31.92, 31.77, 29.98, 28.90, 28.24, 27.58, 27.28, 25.91, 25.26, 24.01, 22.69, 22.66, 14.25, 14.23.

15f, 92% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.23 (d, J = 8.17 Hz, 2H), 8.11 (d, J = 8.26 Hz, 2H), 4.09 (t, J =7.26 Hz, 1H), 3.29-3.20 (m, 2H), 2.92 (brs, 4H), 2.61-2.42 (m, 6H), 2.11-2.02 (m, 2H), 1.95-1.90 (m, 2H), 1.86-1.77 (m, 4H), 1.64-1.58 (m, 2H), 1.37-1.22 (m, 14H), 0.89-0.84 (m, 6H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.40, 169.22, 161.36, 141.37, 131.00, 128.96, 128.76, 62.88, 47.68, 43.21, 31.99, 31.85, 31.80, 30.06, 29.44, 29.30, 28.90, 28.26, 27.60, 25.91, 25.28, 24.29, 22.84, 22.79, 14.32, 14.29.

15g, 94% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.22 (d, J = 8.15 Hz, 2H), 8.10 (d, J = 8.20 Hz, 2H), 4.09 (t, J =7.36 Hz, 1H), 3.27-3.20 (m, 2H), 2.92 (brs, 4H), 2.60-2.49 (m, 6H), 2.10-2.01 (m, 2H), 1.94-1.90 (m, 2H), 1.83-1.72 (m, 4H), 1.64-1.55 (m, 2H), 1.36-1.26 (m, 18H), 0.88-0.85 (m, 6H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.25, 169.36, 161.31, 141.30, 130.85, 128.92, 128.65, 120.91, 71.21, 62.84, 43.12, 31.96, 31.90, 29.95, 29.67, 29.54, 29.27, 29.23, 28.86, 27.53, 25.91, 24.27, 22.79, 14.32.

15h, 91% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.22 (d, J = 8.33 Hz, 2H), 8.10 (d, J = 8.40 Hz, 2H), 4.09 (t, J =7.33 Hz, 1H), 3.28-3.20 (m, 2H), 2.92 (brs, 4H), 2.62-2.46 (m, 6H), 2.11-2.01 (m, 2H), 1.94-1.90 (m, 2H), 1.85-1.74 (m, 4H), 1.62-1.58 (m, 2H), 1.36-1.25 (m, 22H), 0.88 (t, J =6.80 Hz, 6H);

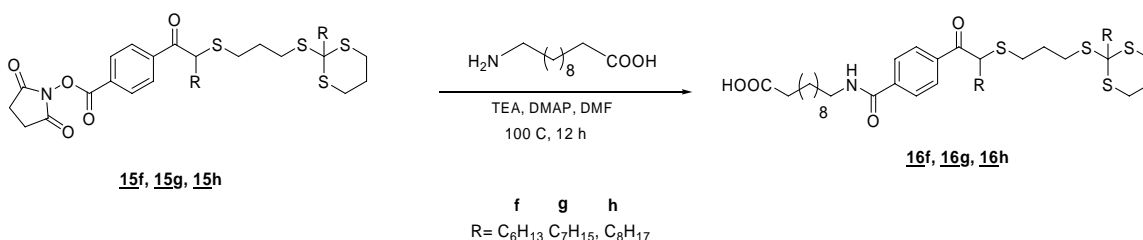
^{13}C NMR (CDCl_3 , 100 MHz): δ 194.37, 169.24, 161.35, 141.36, 130.98, 128.95, 128.74, 62.87, 47.66, 42.20, 32.06, 32.04, 31.97, 30.05, 29.78, 29.63, 29.62, 29.58, 29.47, 29.44, 28.89, 28.25, 27.63, 27.60, 27.59, 25.91, 25.27, 24.33, 22.88, 22.87, 14.36, 14.34.

15i, 92% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.23 (d, J = 8.72 Hz, 2H), 8.10 (d, J = 8.76 Hz, 2H), 4.09 (t, J =7.33 Hz, 1H), 3.28-3.20 (m, 2H), 2.92 (brs, 4H), 2.62-2.39 (m, 6H), 2.11-2.03 (m, 2H), 1.94-1.90 (m, 2H), 1.86-1.73 (m, 4H), 1.64-1.57 (m, 2H), 1.35-1.25 (m, 26H), 0.88 (t, J =6.73 Hz, 6H);

^{13}C NMR (CDCl_3 , 100 MHz): δ 194.37, 169.24, 161.36, 141.36, 130.99, 128.95, 128.74, 62.88, 47.66, 43.21, 32.10, 32.09, 31.98, 30.05, 29.78, 29.74, 29.73, 29.68, 29.64, 29.52, 29.50, 28.90, 28.25, 27.64, 27.60, 27.59, 25.91, 25.28, 24.30, 22.91, 22.89, 14.37, 14.35.

10. General procedure for syntheses of **16f**, **16g** and **16h**



To a mixture 11-aminoundecanoic acid (0.35 mmol) and **15f** (0.32 mmol) in DMF (10 mL) was added triethylamine (2 mL) and a catalytic amount of DMAP. The resulting solution was stirred at 100^o C for 12 h, poured onto crushed ice and acidified with 5% HCl solution. The solid obtained was filtered, washed with water and dried to give the desired compound **16f**.

16f, 86% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.04 (d, J= 8.44 Hz, 2H), 7.84 (d, J= 8.46 Hz, 2H), 6.21 (brt, J=5.59 Hz, 1H), 4.11 (t, J=7.34 Hz, 1H), 3.48 (q, J₁=7.06 Hz, J₂=13.20 Hz, 2H), 3.28-3.20 (m, 2H), 2.61-2.43 (m, 6H), 2.36 (t, J=7.44 Hz, 2H), 2.34-2.01 (m, 2H), 1.93-1.89 (m, 2H), 1.84-1.72 (m, 4H), 1.65-1.53 (m, 6H), 1.42-1.18 (m, 26H), 0.88-0.85 (m, 6H);

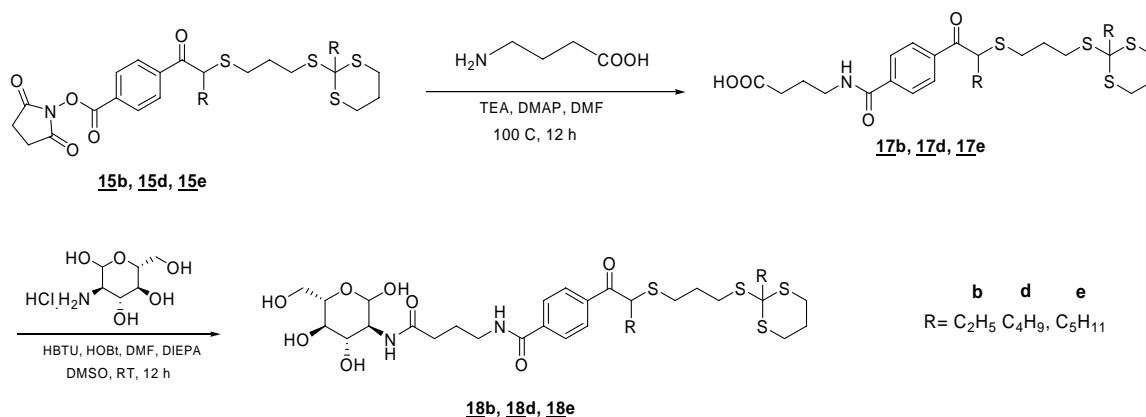
16g, 90% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.02 (d, J= 8.57 Hz, 2H), 7.84 (d, J= 8.52 Hz, 2H), 6.40 (brt, J=5.65 Hz, 1H), 4.09 (t, J=7.31 Hz, 1H), 3.46 (q, J₁=6.79 Hz, J₂=13.35 Hz, 2H), 3.27-3.18 (m, 2H), 2.62-2.40 (m, 6H), 2.34 (t, J=7.46 Hz, 2H), 2.09-2.00 (m, 2H), 1.92-1.87 (m, 2H), 1.83-1.72 (m, 4H), 1.63-1.56 (m, 6H), 1.35-1.23 (m, 30H), 0.87-0.83 (m, 6H);

16h, 87% Yield.

¹H NMR (CDCl₃, 400 MHz): δ 8.05 (d, J= 8.54 Hz, 2H), 7.84 (d, J= 8.52 Hz, 2H), 6.21 (brt, J=5.57 Hz, 1H), 4.11 (t, J=7.32 Hz, 1H), 3.48 (q, J₁=6.97 Hz, J₂=13.28 Hz, 2H), 3.28-3.20 (m, 2H), 2.62-2.43 (m, 6H), 2.36 (t, J=7.46 Hz, 2H), 2.11-2.01 (m, 2H), 1.93-1.89 (m, 2H), 1.84-1.72 (m, 4H), 1.66-1.56 (m, 6H), 1.37-1.22 (m, 34H), 0.89-0.83 (m, 6H);

11. Procedure for syntheses of 18b, 18d and 18e:



General procedure for the syntheses of 17b, 17d and 17e:

To a mixture of 4-aminobutyric acid (0.63 mmol) and **15b** (0.57 mmol) in DMF (15 mL) was added triethylamine (2 mL) and a catalytic amount of DMAP. The resulting solution was stirred at 100°C for 12 h, poured onto crushed ice and acidified with 5% HCl solution. The solid obtained was filtered, washed with water and dried to give pure **17b**.

17b, 92% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.03 (d, $J = 8.31$ Hz, 2H), 7.87 (d, $J = 8.29$ Hz, 2H), 6.85 (brt, $J = 5.55$ Hz, 1H), 4.04 (t, $J = 7.34$ Hz, 1H), 3.57 (q, $J_1 = 6.35$ Hz, $J_2 = 12.40$ Hz, 2H), 3.27-3.19 (m, 2H), 2.61-2.40 (m, 8H), 2.09-1.71 (m, 10H), 1.10 (t, $J = 7.38$ Hz, 3H), 1.04 (t, $J = 7.32$ Hz, 3H);

17d, 87% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.04 (d, $J = 8.38$ Hz, 2H), 7.87 (d, $J = 8.40$ Hz, 2H), 6.75 (brt, $J = 5.54$ Hz, 1H), 4.11 (t, $J = 7.40$ Hz, 1H), 3.58 (q, $J_1 = 6.10$ Hz, $J_2 = 12.42$ Hz, 2H), 3.30-3.21 (m, 2H), 2.60-2.47 (m, 8H), 2.01-1.90 (m, 10H), 1.62-1.54 (m, 2H), 1.38-1.31 (m, 6H), 0.92 (t, $J = 7.28$ Hz, 6H);

17e, 90% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 8.04 (d, $J = 8.51$ Hz, 2H), 7.87 (d, $J = 8.52$ Hz, 2H), 6.72 (brt, $J = 5.55$ Hz, 1H), 4.11 (t, $J = 7.32$ Hz, 1H), 3.58 (q, $J_1 = 6.05$ Hz, $J_2 = 12.38$ Hz, 2H), 3.28-3.20 (m, 2H), 2.61-2.43 (m, 8H), 2.10-1.84 (m, 10H), 1.64-1.58 (m, 2H), 1.50-1.45 (m, 1H), 1.34-1.25 (m, 9H), 0.90 (t, $J = 7.07$ Hz, 6H);

General procedure for the syntheses of 18b, 18d and 18e:

To a mixture of **17b** (0.26 mmol), HBTU (0.29 mmol), and HOBt (0.29 mmol) in DMF (10 mL) was added DIPEA (0.58 mmol) and the reaction mixture was stirred for 5 min at ambient temperature. D-glucosamine hydrochloride (0.29 mmol) was dissolved in 1 mL of DMSO and added to the above reaction mixture and stirred at room temperature for 12 h. The solution was poured into cold ether and allowed to settle down. The ether layer was decanted off and the brownish yellow material was washed with cold ether several times and poured into crushed ice, the obtained solid was filtered and washed with water, hexane to get the pure **18b**.

18b, 65% Yield.

¹H NMR (CD₃OD, 400 MHz): δ 8.11 (d, J= 8.69 Hz, 2H), 7.94 (d, J= 8.67 Hz, 2H), 5.11 (d, J=3.47 Hz, α-anomer), 4.61 (d, J=8.32 Hz, β-anomer), 4.30 (t, J=7.32 Hz, 1H), 3.88-3.61 (m, 4H), 3.48-3.34 (m, 4H), 3.23-3.14 (m, 2H), 2.61-2.54 (m, 3H), 2.49-2.43 (m, 3H), 2.37-2.32 (m, 2H), 2.09-2.01 (m, 2H), 1.96-1.81 (m, 6H), 1.78-1.65 (m, 3H), 1.06 (m, 6H);

¹³C NMR (CD₃OD, 100 MHz): δ 195.79, 174.68, 167.95, 138.81, 138.34, 128.60, 127.47, 91.41, 71.94, 71.47, 71.30, 63.15, 61.64, 54.70, 48.79, 39.32, 35.73, 33.18, 31.33, 28.73, 28.01, 27.11, 27.10, 25.51, 25.08, 23.24, 11.02, 8.08.

18d, 64% Yield.

¹H NMR (CD₃OD, 400 MHz): δ 8.10 (d, J= 8.44 Hz, 2H), 7.94 (d, J= 8.30 Hz, 2H), 5.11 (d, J=3.58 Hz, α-anomer), 4.61 (d, J=8.34 Hz, β-anomer), 4.35 (t, J=7.32 Hz, 1H), 3.89-3.68 (m, 4H), 3.48-3.34 (m, 4H), 3.24-3.15 (m, 2H), 2.64-2.44 (m, 6H), 2.37-2.31 (m, 2H), 2.07-1.77 (m, 11H), 1.60-1.47 (m, 3H), 1.41-1.26 (m, 5H), 0.94-0.88 (m, 6H);

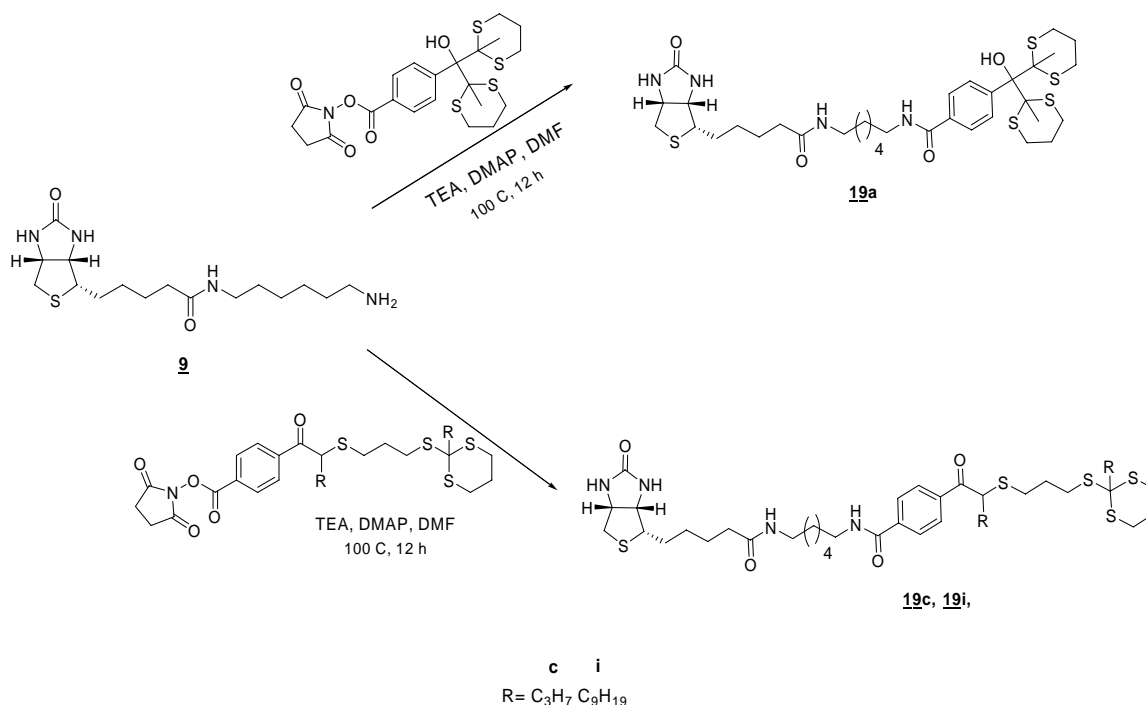
¹³C NMR (CD₃OD, 100 MHz): δ 195.70, 174.66, 167.94, 138.80, 138.36, 128.58, 127.47, 91.40, 71.93, 71.46, 71.31, 62.36, 61.63, 54.70, 46.99, 42.66, 39.30, 33.47, 33.16, 31.43, 29.88, 29.47, 28.70, 28.05, 27.15, 26.28, 25.50, 25.09, 22.58, 22.49, 13.20.

18e, 62% Yield.

¹H NMR (CD₃OD, 400 MHz): δ 8.10 (d, J= 8.50 Hz, 2H), 7.98 (d, J= 8.30 Hz, 2H), 5.25 (d, J=3.49 Hz, α-anomer), 4.77 (d, J=8.34 Hz, β-anomer), 4.36 (t, J=7.35 Hz, 1H), 3.92-3.71 (m, 4H), 3.46-3.34 (m, 4H), 3.25-3.15 (m, 2H), 2.68-2.44 (m, 7H), 2.10-1.98 (m, 2H), 1.92-1.81 (m, 7H), 1.63-1.52 (m, 4H), 1.39-1.24 (m, 11H), 0.91-0.88 (m, 6H);

¹³C NMR (CD₃OD, 100 MHz): δ 195.72, 174.67, 167.92, 138.80, 138.34, 128.58, 127.49, 91.40, 71.93, 71.45, 71.30, 62.42, 61.63, 54.65, 42.88, 42.63, 31.70, 31.45, 30.14, 28.73, 28.07, 27.16, 26.94, 25.10, 23.75, 22.45, 22.40, 17.56, 16.12, 13.23, 12.04.

12. Procedure for syntheses of **19a**, **19c** and **19i**



To a mixture of **9** (0.29 mmol) and **15a** (0.22 mmol) in DMF (10 mL) was added triethylamine (1 mL) and a catalytic amount of DMAP. The resulting solution was stirred at 100^o C for 12 h, was poured onto crushed ice and the solid obtained was filtered, washed with water and dried to give pure **19a**.

19a, 87% Yield.

¹H NMR (CD₃OD, 400 MHz): δ 8.50 (dd, $J_1 = 1.91$ Hz, $J_2 = 8.48$ Hz, 1H), 7.92 (d, $J = 2.01$ Hz, 1H), 7.73 (dd, $J_1 = 2.07$ Hz, $J_2 = 8.38$ Hz, 1H), 7.66 (dd, $J_1 = 2.07$ Hz, $J_2 = 8.49$ Hz, 1H), 4.47-4.41 (m, 1H), 4.29-4.24 (m, 1H), 3.39 (t, $J = 7.07$ Hz, 2H), 3.21-3.15 (m, 2H), 2.92-2.62 (m, 9H), 2.50-2.44 (m, 2H), 2.21 (t, $J = 7.37$ Hz, 2H), 2.12 (s, 6H), 1.90-1.83 (m, 2H), 1.76-1.58 (m, 8H), 1.56-1.49 (m, 2H), 1.46-1.40 (m, 6H);

¹³C NMR (CD₃OD, 100 MHz): δ 178.72, 172.87, 148.51, 137.30, 134.82, 128.86, 127.84, 90.70, 66.70, 66.13, 64.36, 59.79, 43.81, 43.60, 42.97, 39.58, 33.22, 33.09, 32.56, 32.28, 31.94, 31.59, 31.55, 30.78, 30.74, 30.70, 30.45, 30.37, 29.72, 28.06.

19c, 90% Yield.

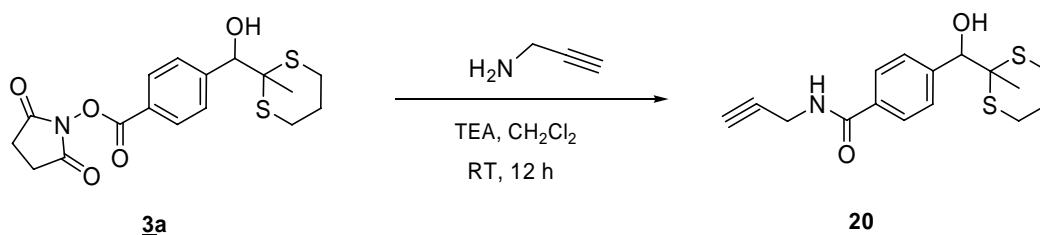
¹H NMR (DMSO-*d*₆, 400 MHz): δ 8.62 (brt, $J = 5.70$ Hz, 1H), 8.08 (d, $J = 8.46$ Hz, 2H), 7.93 (d, $J = 8.40$ Hz, 2H), 7.74 (brt, $J = 5.52$ Hz, 1H), 6.42 (brd, 2H), 4.54 (t, $J = 7.29$ Hz, 1H), 4.29-4.26 (m, 1H), 4.11-4.08 (m, 1H), 3.26-3.20 (m, 2H), 3.09-2.96 (m, 6H), 2.81 (dd, $J_1 = 4.49$ Hz, $J_2 = 12.39$ Hz, 2H), 2.67-2.63 (m, 2H), 2.57-2.52 (m, 2H), 2.45-2.36 (m, 3H), 2.04-1.96 (t, $J = 7.40$ Hz, 2H), 1.83-1.79 (m, 2H), 1.70-1.55 (m, 6H), 1.52-1.42 (m, 8H), 1.35-1.24 (m, 8H), 0.91-0.83 (m, 6H);

^{13}C NMR (DMSO- d_6 , 100 MHz): δ 172.46, 165.88, 163.37, 163.33, 138.35, 129.04, 128.10, 62.89, 61.71, 59.86, 59.74, 56.13, 46.39, 45.26, 38.97, 35.90, 35.86, 32.51, 31.76, 29.84, 29.71, 29.16, 28.90, 28.72, 28.43, 27.45, 27.43, 26.89, 26.85, 26.83, 26.04, 25.17, 20.61, 18.02, 14.54, 14.49.

19i, 92% Yield.

^1H NMR (DMSO- d_6 , 400 MHz): δ 8.62 (brt, $J=5.79$ Hz, 1H), 8.06 (d, $J=8.24$ Hz, 2H), 7.93 (d, $J=8.21$ Hz, 2H), 7.74 (brt, $J=5.37$ Hz, 1H), 6.42 (brd, 2H), 4.52 (t, $J=7.10$ Hz, 1H), 4.29-4.26 (m, 1H), 4.11-4.08 (m, 1H), 3.26-3.21 (m, 2H), 3.07-2.98 (m, 6H), 2.81 (dd, $J_1=5.16$ Hz, $J_2=12.37$ Hz, 2H), 2.68-2.62 (m, 2H), 2.58-2.52 (m, 2H), 2.47-2.35 (m, 3H), 2.04-1.96 (m, 2H), 1.85-1.81 (m, 2H), 1.71-1.57 (m, 6H), 1.52-1.44 (m, 8H), 1.28-1.21 (m, 32H), 0.86-0.81 (m, 6H);

13. Procedure for the synthesis of 20



To a mixture mono-propargylamine (18 mg, 0.31 mmol) and **3a** (100 mg, 0.26 mmol) in CH_2Cl_2 (10 mL) was added triethylamine (2 mL). The resulting solution was stirred at room temperature for 12 h, washed with 5% HCl, then water, and dried over anhyd. Na_2SO_4 . The solvent was evaporated to obtain the pure compound.

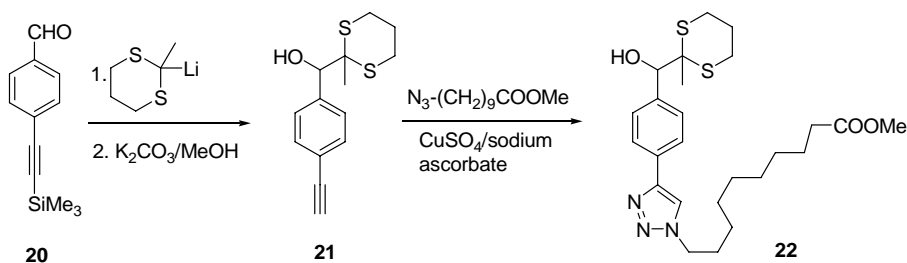
20, 95% Yield.

^1H NMR (CDCl_3 , 400 MHz): δ 7.73 (d, $J=8.27$ Hz, 2H), 7.56 (d, $J=8.25$ Hz, 2H), 6.33 (brt, 1H), 5.13 (s, 1H), 4.25-4.23 (m, 2H), 3.35 (s, 1H), 3.24-3.17 (m, 1H), 3.11-3.03 (m, 1H), 2.75-2.65 (m, 2H), 2.28 (t, $J=2.49$ Hz, 1H), 2.20-2.15 (m, 1H), 1.96-1.85 (m, 1H), 1.24 (s, 3H);

^1H NMR (CD_3OD , 400 MHz): δ 7.77 (d, $J=8.14$ Hz, 2H), 7.58 (d, $J=8.14$ Hz, 2H), 5.09 (s, 1H), 4.15 (d, $J=2.07$ Hz, 2H), 3.19-3.02 (m, 2H), 2.70-2.66 (m, 2H), 2.59 (s, 1H), 2.04-2.00 (m, 1H), 1.88-1.82 (m, 1H), 1.32 (s, 3H);

^{13}C NMR (CD_3OD , 100 MHz): δ 168.44, 144.05, 133.10, 128.80, 126.01, 79.67, 76.48, 70.96, 52.84, 28.83, 26.58, 26.04, 24.61, 22.62.

14. Procedure for the synthesis of 21 and 22.



3.4 mL (14.3 mmol) of a 1.6M THF solution of butyllithium was added to a solution of methyl dithiane (0.66 g, 4.94 mmol) in dry THF (20 mL) dropwise during 3 min at RT, and the resulting solution was stirred at RT for 10 min. 4-((trimethylsilyl)ethynyl)benzaldehyde (0.5 g, 2.47 mmol) in 10 mL THF was added to the generated anion. The resulting solution was stirred at RT for 5 h. Saturated NH_4Cl (20 mL) was added to it and stirred for 10 min. The resulting solution was extracted with EtOAc (3 x 50 mL). The organic layer was dried over Na_2SO_4 and the solvent was evaporated. The residue was re-dissolved in 20 mL MeOH containing 0.34 g of K_2CO_3 and stirred overnight at ambient temperature. The solution was poured onto crushed ice and acidified with 5% HCl and extracted with ethyl acetate (50 mL). The organic layer was dried over Na_2SO_4 and the solvent was removed in vacuum. The product was purified by column chromatography with 5% EtOAc-hexane as eluent to give pure **21** (0.59 g, yield 90%).

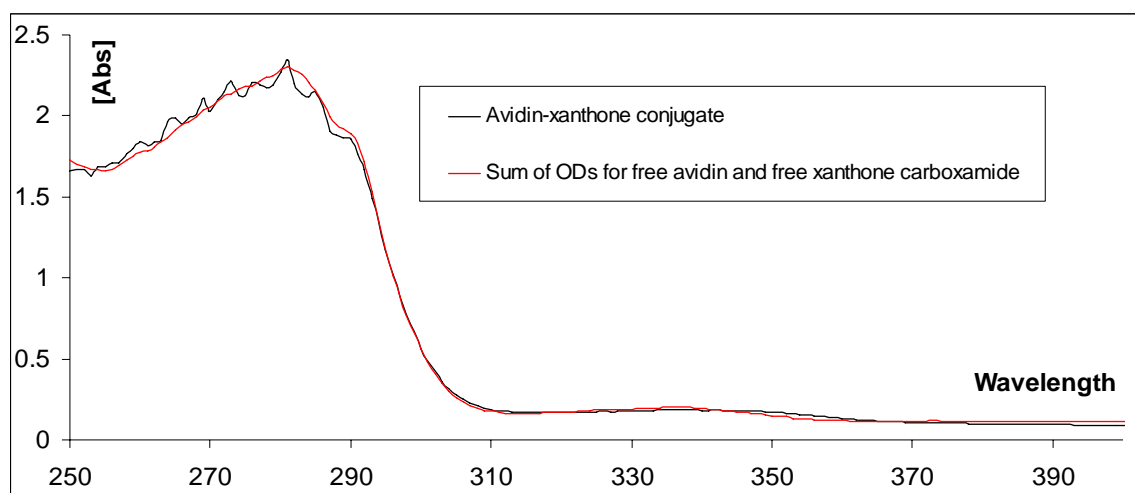
^1H NMR (CDCl_3 , 400 MHz): δ 7.44 (s, 4H), 5.07 (d, $J=1.0\text{Hz}$, 1H), 3.31 (d, $J=1.2\text{Hz}$, 1H), 3.17 (ddd, $J=2.9\text{Hz}$, $J=11.8\text{Hz}$, $J=14.5\text{Hz}$, 1H), 3.08 (s, 1H), 3.04 (ddd, $J=2.6\text{Hz}$, $J=11.9\text{Hz}$, $J=14.5\text{Hz}$, 1H), 2.74-2.62 (m, 2H), 2.18-2.10 (m, 1H), 1.95-1.83 (m, 1H), 1.25 (s, 3H)

Sodium ascorbate (43 mg, 0.22 mmol) was added to a mixture of acetylene **21** (0.29 g, 1.1 mmol) and methyl 10-azidodecanoate (0.27 g, 1.2 mmol) in 20 mL of ethanol, followed by addition of copper(II) sulfate pentahydrate (7.5% in water, 193 μL , 0.15 mmol). This heterogeneous mixture was stirred vigorously for 24 h at room temperature. The solvent was removed in vacuum, the residue was dissolved in dichloromethane and the organic layer was washed with water, dried over Na_2SO_4 and evaporated to give pure **22** (0.51 g, yield 95%).

^1H NMR (CDCl_3 , 400 MHz): δ 7.78 (d, $J=8.2\text{Hz}$, 2H), 7.73 (s, 1H), 7.53 (d, $J=8.1\text{Hz}$, 2H), 5.12 (s, 1H), 4.38 (t, $J=7.1\text{Hz}$, 3H), 3.65 (s, 3H), 3.30 (s, 1H), 3.22 (ddd, $J=2.4\text{Hz}$, $J=11.9\text{Hz}$, $J=14.4\text{Hz}$, 1H), 3.08 (ddd, $J=2.4\text{Hz}$, $J=12.0\text{Hz}$, $J=14.4\text{Hz}$, 1H), 2.71 (m, 2H), 2.28 (t, 1H, $J=7.5\text{Hz}$), 2.17 (m, 1H), 1.93 (m, 2H+1H), 1.59 (m, 2H), 1.35-1.25 (m, 8H & s, 3H).

15. Procedure for the modification of Avidin with ET-Sensitizer

To a solution of Avidin (10 mg, 0.147 μmol) in 1 mL 20 mM sodium phosphate buffer was added 100 μL of **13** (5 mg/mL in DMSO). The resulting mixture was gently shaken on a shaker for 2 h at ambient temperature. The excess reagent and reaction by-products were removed using a Sephadex G-25 column. The degree of immobilization was quantified spectroscopically, by fitting the UV absorption of the conjugate, A_{conj} , with a scaled sum of UV spectra of the original avidin, A_{av} , and 2-butylaminocarbonylxanthone, A_{x} , in the range from 240 to 390 nm: $A_{\text{conj}} = k_{\text{av}} A_{\text{av}}[av] + k_{\text{x}} A_{\text{x}}[x]$, where $[av]$ and $[x]$ are the respective molar concentrations of avidin and the xanthone carboxamide. The ratio of scaling factors $k_{\text{x}}/k_{\text{av}}$ was determined to be 0.77 (rms fit is 0.003 over 150 data points) indicating that each tetramer of avidin was carrying approximately three tethered xanthone-2-carboxylate moieties on average.



16. Formation of micelle and photochemistry

0.5 mg each of **10a**, **6b**, **6c**, **6d**, **4e**, **10f**, **4g**, **4h** and **10i** were added to a solution of DPC (60 mg) in 0.6 mL of D_2O . The mixture was stirred for 24 h at ambient temperature until a clear micellar solution was obtained. To this solution 0.5 mL of avidin-xanthone conjugate was added. The resulting solution was incubated in an orbital shaker for 1 h, degassed with argon for 45 min and then irradiated for 4 h using Rayonet reactor (RPR-3500 lamps) and a 330 nm long pass solution filter. The micellar solution was extracted with 0.5 mL hexane and concentrated to 0.1 mL to be analyzed by GCMS.