

## SUPPORTING INFORMATION FOR

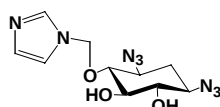
### An efficient synthesis of mimetic of neamine for RNA recognition

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Ibis Therapeutics, a Division of Isis Pharmaceuticals, 2292 Faraday Avenue, Carlsbad, CA 92008

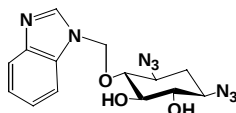
NMR spectroscopic data for compounds **5-34**.

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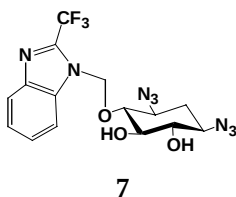
**5**

Compound **5**.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.82 (s, 1H), 7.28 (s, 1H), 7.00 (s, 1H), 5.67 (q, 2H), 3.48-3.20 (m, 5H), 2.30 (dt, 1H), 1.22 (q, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  137.9, 128.1, 119.8, 82.6, 77.0, 76.5, 75.9, 60.7, 59.8, 32.1.

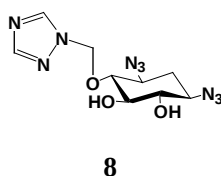


**6**

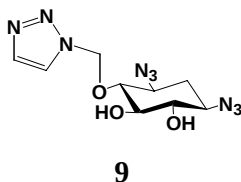
Compound **6**.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.10 (s, 1H), 7.75 (d, 1H,  $J = 7.6$  Hz), 7.58 (d, 1H,  $J = 8.0$  Hz), 7.31 (m, 2H), 5.93 (d, 1H,  $J = 10.8$  Hz), 5.72 (d, 1H,  $J = 10.4$  Hz), 3.49-3.16 (m, 5H), 2.12 (dt, 1H,  $J = 13.2, 4.0$  Hz); 1.23 (q, 1H,  $J = 10.8$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  143.9, 142.9, 133.6, 124.2, 123.5, 120.1, 110.5, 81.9, 76.3, 75.6, 75.3, 60.1, 60.0, 32.4.



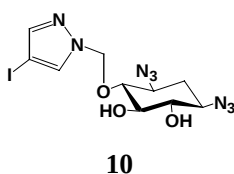
Compound **7**.  $^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  7.85 (d, 1H,  $J = 8.0$  Hz), 7.79 (d, 1H,  $J = 8.0$  Hz), 7.52 (td, 1H,  $J = 8.4, 1.2$  Hz), 7.43 (td, 1H,  $J = 7.2, 1.2$  Hz), 6.11 (d, 1H,  $J = 11.2$  Hz), 6.01 (d, 1H,  $J = 11.2$  Hz), 3.43 (m, 5H), 2.06 (dt, 1H,  $J = 12.8, 4.4$  Hz), 1.21 (q, 1H,  $J = 13.2$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  140.7, 135.7, 125.9, 124.2, 121.0, 120.4, 117.9, 111.8, 84.1, 76.6, 75.9, 74.9, 60.7, 59.8, 32.2.



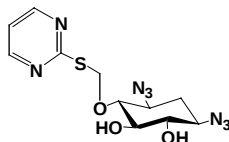
Compound **8**.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.68 (s, 2H), 5.77 (ABq, 2H), 3.52-3.22 (m, 5H), 2.09 (dt, 1H,  $J = 13.2, 4.4$  Hz), 1.26 (q, 1H,  $J = 12.4$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  143.7, 83.9, 76.4, 75.7, 75.4, 60.7, 59.7, 31.9.



Compound **9**.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.74 (s, 1H), 6.08 (d, 1H,  $J = 10.8$  Hz), 5.89 (d, 1H,  $J = 10.8$  Hz), 3.51-3.32 (m, 5H), 2.20 (dt, 1H), 1.20 (q, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  135.8, 84.4, 83.4, 76.0, 75.0, 59.9, 59.8, 32.3.

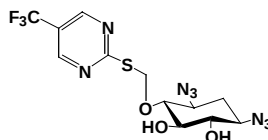


Compound **10**.  $^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  7.93 (s, 1H), 7.57 (s, 1H), 5.72 (q, 2H,  $J$  = 8.4 Hz), 3.42-3.22 (m, 5H), 2.06 (dt, 1H,  $J$  = 9.2, 3.6 Hz), 1.20 (q, 1H,  $J$  = 12.4 Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  145.2, 135.7, 83.3, 81.2, 76.3, 75.7, 60.7, 59.8, 57.2, 32.2.



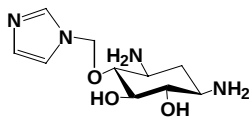
**11**

Compound **11**.  $^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  8.59 (d, 1H,  $J$  = 5.2 Hz), 7.17 (t, 1H,  $J$  = 4.8 Hz), 5.81 (d, 1H,  $J$  = 11.2 Hz), 5.56 (d, 1H,  $J$  = 11.2 Hz), 3.51-3.24 (m, 5H), 2.05 (dt, 1H,  $J$  = 12.8, 4.4 Hz), 1.22 (q, 1H,  $J$  = 12.4 Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  170.7, 157.7, 117.6, 83.5, 76.4, 76.1, 72.6, 60.9, 59.8, 32.3.



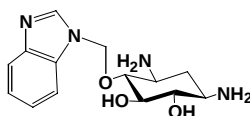
**12**

Compound **12**.  $^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  8.87 (d, 1H,  $J$  = 5.2 Hz), 7.52 (d, 1H,  $J$  = 5.2 Hz), 5.86 (d, 1H,  $J$  = 11.6 Hz), 5.66 (d, 1H,  $J$  = 11.6 Hz), 3.53 (t, 1H,  $J$  = 9.2 Hz), 3.42-3.28 (m, 3H), 3.24 (t, 1H,  $J$  = 9.6 Hz), 2.04 (dt, 1H,  $J$  = 12.8, 4.4 Hz), 1.19 (q, 1H,  $J$  = 12.8 Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  83.8, 76.5, 76.2, 60.8, 59.8, 32.3.



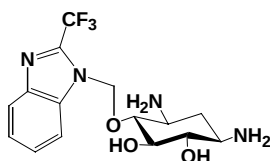
**13**

Compound **13**.  $^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  8.86 (s, 1H), 7.56 (s, 1H), 7.42 (s, 1H), 5.89 (d, 1H,  $J = 10.8$  Hz), 5.70 (d, 1H,  $J = 10.8$  Hz), 3.66 (t, 1H,  $J = 9.2$  Hz), 3.48-3.38 (m, 3H), 3.20 (m, 1H), 2.35 (dt, 1H,  $J = 12.4$ , 3.6 Hz), 1.73 (q, 1H,  $J = 12.4$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  135.7, 121.7, 120.4, 80.7, 78.9, 74.7, 72.7, 49.9, 49.0, 28.2.



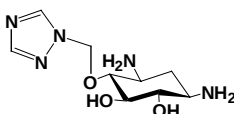
**14**

Compound **14**.  $^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  9.35 (s, 1H), 7.89 (m, 1H), 7.87 (m, 1H), 7.60 (m, 2H), 6.22 (d, 1H,  $J = 11.6$  Hz), 6.01 (d, 1H,  $J = 11.6$  Hz), 3.79 (t, 1H,  $J = 9.6$  Hz), 3.43 (t, 1H,  $J = 10.0$  Hz), 3.39 (m, 1H), 3.34 (t, 1H,  $J = 8.8$  Hz), 3.17 (td, 1H,  $J = 12.0$ , 4.0 Hz), 2.37 (dt, 1H,  $J = 12.8$ , 4.4 Hz), 1.79 (q, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  81.4, 77.4, 74.5, 72.7, 49.9, 49.2, 28.1.



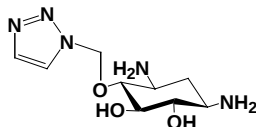
**15**

Compound **15**.  $^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  7.74 (d, 1H,  $J = 8.0$  Hz), 7.70 (d, 1H,  $J = 8.4$  Hz), 7.50 (t, 1H,  $J = 8.0$  Hz), 7.41 (t, 1H,  $J = 8.0$  Hz), 3.70 (t, 1H,  $J = 9.2$  Hz), 3.56-3.36 (m, 2H), 3.31 (td, 1H,  $J = 12.8$ , 3.6 Hz), 3.18 (td, 1H,  $J = 13.2$ , 4.0 Hz), 2.33 (dt, 1H,  $J = 12.8$ , 4.4 Hz), 1.73 (q, 1H,  $J = 12.8$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  80.5, 75.1, 74.9, 72.8, 50.0, 49.1, 28.2.



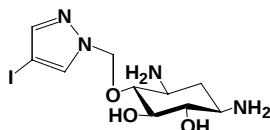
**16**

Compound **16**.  $^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  8.96 (s, 2H), 5.91 (d, 1H,  $J = 11.2$  Hz), 5.73 (d, 1H,  $J = 11.2$  Hz), 3.65 (t, 1H,  $J = 10.0$  Hz), 3.46-3.30 (m, 3H), 3.18 (m, 1H), 2.35 (dt, 1H,  $J = 12.8, 4.4$  Hz), 1.73 (q, 1H,  $J = 12.8$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  80.8, 76.5, 74.6, 72.6, 49.9, 48.9, 28.1.



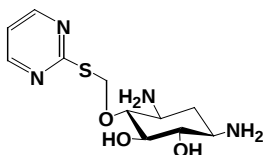
**17**

Compound **17**.  $^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  8.09 (s, 1H), 7.78 (s, 1H), 6.09 (d, 1H,  $J = 11.2$  Hz), 5.93 (d, 1H,  $J = 11.2$  Hz), 3.67 (t, 1H,  $J = 9.6$  Hz), 3.60-3.40 (m, 2H), 3.32 (td, 1H,  $J = 10.0, 4.4$  Hz), 3.19 (td, 1H,  $J = 9.2, 4.4$  Hz), 2.33 (dt, 1H,  $J = 12.4, 4.4$  Hz), 1.70 (q, 1H,  $J = 12.8$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  134.3, 126.7, 79.8, 79.1, 75.0, 72.5, 50.0, 48.9, 28.1.



**18**

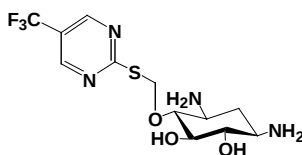
Compound **18**.  $^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  7.89 (s, 1H), 7.65 (s, 1H), 5.71 (d, 1H,  $J = 10.8$  Hz), 5.63 (d, 1H,  $J = 11.2$  Hz), 3.55 (t, 1H,  $J = 8.8$  Hz), 3.55-3.42 (m, 2H), 3.28 (td, 1H,  $J = 10.0, 4.0$  Hz), 3.20 (td, 1H,  $J = 10.0, 4.4$  Hz), 2.33 (dt, 1H,  $J = 12.8, 4.4$  Hz), 1.70 (q, 1H,  $J = 12.8$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  147.0, 137.1, 80.5, 78.8, 75.2, 72.4, 50.0, 49.0, 28.1



**19**

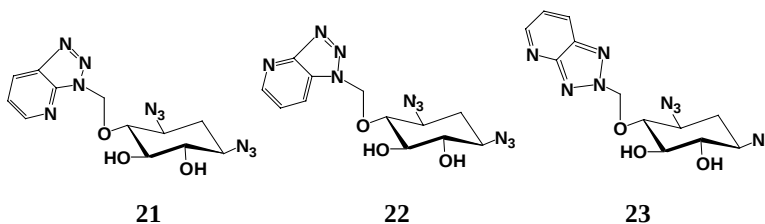
Compound **19**.  $^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  8.57 (m, 2H), 7.25 (m, 1H), 5.52 (d, 1H,  $J = 11.2$  Hz), 5.44 (d, 1H,  $J = 11.6$  Hz), 3.71 (t, 1H,  $J = 8.8$  Hz), 3.55-3.47 (m, 2H), 3.31 (dt, 1H,  $J = 12.4, 4.0$  Hz), 3.23 (m, 1H), 2.39 (dt,

1H), 1.77 (q, 1H,  $J = 12.8$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  169.2, 158.5, 118.8, 79.7, 75.1, 73.1, 72.5, 50.2, 49.2, 28.1.



20

Compound **20**.  $^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  8.84 (d, 1H,  $J = 5.2$  Hz), 7.60 (d, 1H,  $J = 4.8$  Hz), 5.60 (ABq, 2H,  $J = 11.6, 4.4$  Hz), 3.74 (t, 1H), 3.56-3.46 (m, 2H), 3.32-3.16 (m, 2H), 2.37 (dt, 1H,  $J = 12.4, 4.0$  Hz), 1.75 (q, 1H,  $J = 12.4$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  171.0, 161.3, 130.0, 114.5, 79.6, 75.2, 73.3, 72.6, 50.2, 49.1, 28.1.



21

22

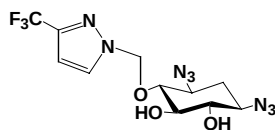
23

Compounds **21**, **22** and **23**:

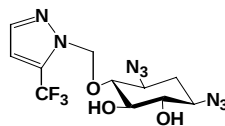
$^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  8.80 (dd, 1H,  $J = 4.4, 1.6$  Hz), 8.43 (dd, 1H,  $J = 8.8, 2.0$  Hz), 7.52 (q, 1H,  $J = 4.0$  Hz), 6.38 (s, 2H), 3.62-3.21 (m, 5H), 2.02 (dt, 1H), 1.15 (q, 1H);

$^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  8.75 (dd, 1H,  $J = 4.8, 1.6$  Hz), 8.48 (dd, 1H,  $J = 8.4, 1.2$  Hz), 7.52 (q, 1H,  $J = 4.8$  Hz), 6.35 (d, 1H,  $J = 10.8$  Hz), 6.27 (d, 1H,  $J = 10.8$  Hz), 3.62-3.21 (m, 5H), 2.02 (dt, 1H), 1.15 (q, 1H);

$^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  8.72 (dd, 1H,  $J = 3.2, 1.6$  Hz), 8.43 (dd, 1H,  $J = 10.8, 2.0$  Hz), 7.63 (q, 1H,  $J = 4.4$  Hz), 6.41 (d, 1H,  $J = 11.6$  Hz), 6.36 (d, 1H,  $J = 11.6$  Hz), 3.62-3.21 (m, 5H), 2.02 (dt, 1H), 1.15 (q, 1H).



**24**

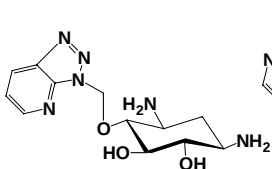


**25**

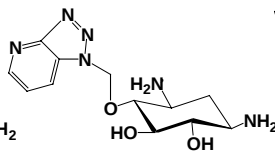
Compounds **24** and **25**:

$^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  7.96 (s, 1H), 6.65 (d, 1H,  $J = 2.0$  Hz), 5.81 (d, 1H,  $J = 11.2$  Hz), 5.77 (d, 1H,  $J = 11.2$  Hz), 3.56-3.21 (m, 5H), 2.06 (dt, 1H,  $J = 13.2, 4.4$  Hz), 1.19 (q, 1H,  $J = 12.8$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  83.6, 81.7, 76.4, 75.8, 60.7, 59.8, 32.2.

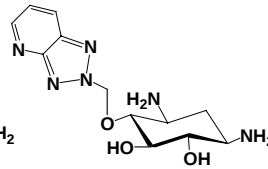
$^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  7.64 (s, 1H), 6.81 (s, 1H), 5.85 (s, 2H), 3.56-3.21 (m, 5H), 2.06 (dt, 1H,  $J = 13.2, 4.4$  Hz), 1.20 (q, 1H,  $J = 12.4$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  83.9, 80.1, 76.4, 75.9, 60.7, 59.7, 32.3.



**26**



**27**



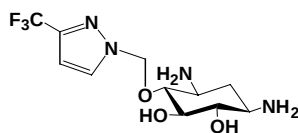
**28**

Compounds **26**, **27** and **28**:

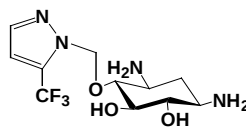
$^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  8.71 (d, 1H,  $J = 3.6$  Hz), 8.36 (dd, 1H,  $J = 8.8, 1.2$  Hz), 7.48 (q, 1H,  $J = 4.8$  Hz), 6.38 (d, 1H,  $J = 11.2$  Hz), 6.21 (d, 1H,  $J = 11.2$  Hz), 3.55 (t, 1H,  $J = 9.2$  Hz), 3.48-3.34 (m, 3H), 3.20 (m, 1H), 2.36 (dt, 1H), 1.74 (q, 1H);

$^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  8.66 (dd, 1H,  $J = 4.4, 1.2$  Hz), 8.42 (dd, 1H,  $J = 8.4, 1.2$  Hz), 7.49 (q, 1H,  $J = 4.8$  Hz), 6.37 (d, 1H,  $J = 11.6$  Hz), 6.26 (d, 1H,  $J = 11.6$  Hz), 3.83 (t, 1H,  $J = 10.4$  Hz), 3.48-3.36 (m, 3H), 3.22 (m, 1H), 2.36 (dt, 1H), 1.76 (q, 1H);

$^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  8.62 (d, 1H,  $J = 4.0$  Hz), 8.32 (dd, 1H,  $J = 8.0, 1.2$  Hz), 7.59 (q, 1H,  $J = 4.4$  Hz), 6.41 (d, 1H,  $J = 12.8$  Hz), 6.22 (d, 1H,  $J = 11.6$  Hz), 3.79 (t, 1H), 3.48-3.33 (m, 3H), 3.22 (m, 1H), 2.35 (dt, 1H), 1.72 (q, 1H).



**29**

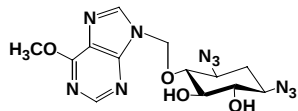


**30**

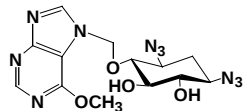
Compounds **29** and **30**:

$^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  7.87 (s, 1H), 6.69 (d, 1H,  $J = 2.0$  Hz), 5.79 (d, 1H,  $J = 11.2$  Hz), 5.71 (d, 1H,  $J = 11.2$  Hz), 3.59 (t, 1H,  $J = 9.2$  Hz), 3.52-3.42 (m, 2H), 3.31 (td, 1H), 3.19 (td, 1H), 2.33 (dt, 1H), 1.71 (q, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  81.2, 79.3, 75.2, 72.5, 50.0, 49.1, 28.1.

$^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  7.65 (s, 1H), 6.82 (s, 1H), 5.84 (d, 1H,  $J = 11.2$  Hz), 5.79 (d, 1H,  $J = 11.2$  Hz), 3.71 (t, 1H,  $J = 9.2$  Hz), 3.54-3.42 (m, 2H), 3.32 (m, 1H), 3.19 (m, 1H), 2.33 (dt, 1H), 1.68 (q, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  80.1, 79.7, 75.1, 72.6, 50.0, 49.2, 28.1.



**31**

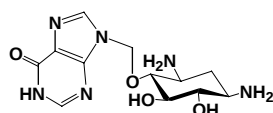


**32**

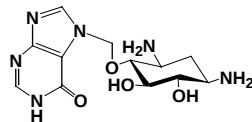
Compounds **31** and **32**:

$^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  8.55 (s, 1H), 8.54 (s, 1H), 5.95 (ABq, 2H,  $J = 12.8$  Hz), 4.18 (s, 3H), 3.56-3.21 (m, 5H), 2.04 (dt, 1H,  $J = 12.8, 4.8$  Hz), 1.17 (q, 1H,  $J = 12.8$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  84.4, 76.3, 75.5, 74.3, 60.7, 59.9, 53.7, 32.1.

$^1\text{H}$  NMR (400 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  8.43 (s, 2H), 6.04 (d, 1H,  $J = 11.2$  Hz), 5.99 (d, 1H,  $J = 11.2$  Hz), 4.19 (s, 3H), 2.04 (dt, 1H,  $J = 12.8, 4.8$  Hz), 1.17 (q, 1H,  $J = 12.8$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CD}_3\text{OD}$ )  $\delta$  83.8, 77.5, 76.5, 75.6, 60.7, 59.9, 53.8, 32.2.



**33**



**34**

Compounds **33** and **34**:

$^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  8.62 (s, 1H), 8.21 (s, 1H), 5.94 (d, 1H,  $J = 10.8$  Hz), 5.84 (d, 1H,  $J = 10.8$  Hz), 3.73 (m, 1H), 3.46-3.32 (m, 3H), 3.17 (m, 1H), 2.36 (dt, 1H,  $J = 12.4, 3.6$  Hz), 1.75 (q, 1H,  $J = 12.4$  Hz);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  80.4, 74.9, 74.8, 72.6, 50.0, 49.2, 28.2.

$^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  8.70 (s, 1H), 8.19 (s, 1H), 5.99 (d, 1H,  $J = 10.4$  Hz), 5.94 (d, 1H,  $J = 10.4$  Hz), 3.73 (t, 1H), 3.48-3.32 (m, 3H), 3.18 (m, 1H), 2.36 (dt, 1H,  $J = 12.4, 3.6$  Hz), 1.78 (q, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{D}_2\text{O}$ )  $\delta$  80.6, 77.7, 74.8, 72.6, 50.0, 49.1, 28.2.