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Supporting Information

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Highly Selective Recognition of Adenine Nucleobase by Synthetic Hosts with Linked Five-Six-Five-Membered Triheteroaromatic Structure and the Application to Potentiometric Sensing of Adenine Nucleotide

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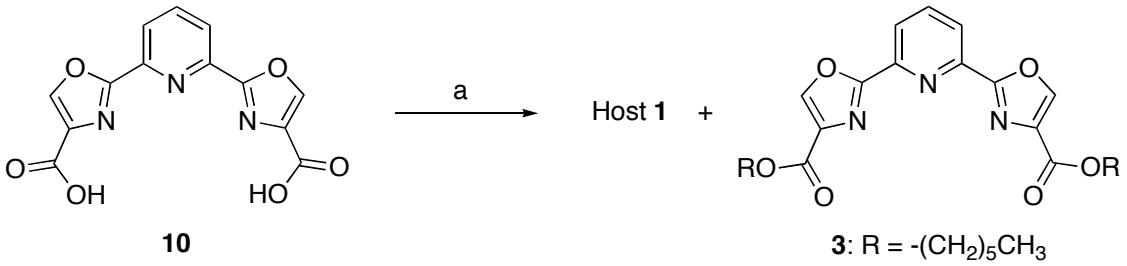
I. Synthesis and Characterization of Compounds

Synthesis of Reference 3

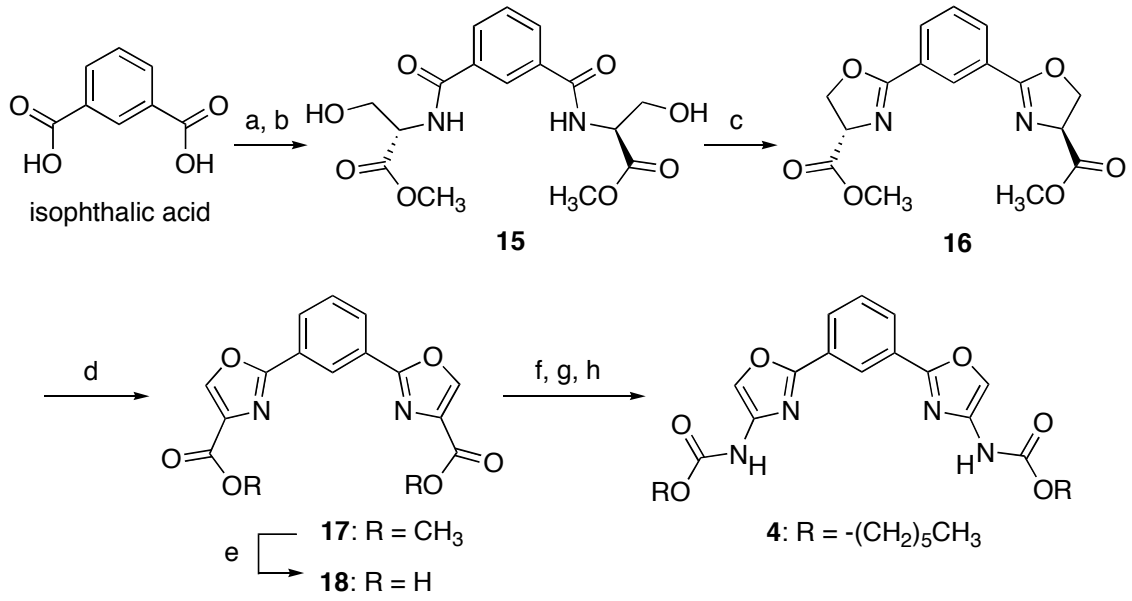


Scheme S1. Synthesis of host **1** (and reference **3**). a) DPPA (2.5 eq), Et_3N, DMF, RT, 20 h; then 1-hexanol, DMF, 100 ˚C, 2 h; **1** (41%) and **3** (22%).

Other Preparative Method for 1 (and 3): Compound **1** was also prepared by employing the reported procedure using diphenylphosphoryl azide (DPPA).[S1] To a stirred solution of **10** (120 mg, 0.4 mmol) in DMF (5 mL) was added successively Et_3N (350 mg, 3.5 mmol) and DPPA (550 mg, 2 mmol) in one portion, respectively, at RT under N_2 atmosphere. After stirred for 20 h, 1-hexanol (10 mL) was added and the reaction mixture was heated at 100 °C for 2 h. The resulting solution was diluted with $CHCl_3$ (90 mL), and the organic layer was washed successively with 5% aq citric acid (25 mL), satd aq $NaHCO_3$ (25 mL) and brine (25 mL). The aqueous layers were extracted again with $CHCl_3$ (25 mL), and the extract was washed with brine (25 mL). The combined organic layers were dried over anhyd $MgSO_4$, filtered and evaporated. The residue was purified by column chromatography (alumina, $CHCl_3$-hexane = 1:1) to give **1** (white solid, 82 mg, 41%), together with **3** (white solid, 41 mg, 22%).

2,2'-(Pyridine-2,6-diyl)bis(oxazole-4-carboxylic acid) Dihexyl Ester (3): mp 117-119 °C (recrystallized from EtOH). ^{1}H-NMR (400 MHz, $CDCl_3$, TMS): δ = 0.91 (t, ^3J(H,H) = 7.0 Hz, 6 H; CH_3), 1.26-1.47 (m, 12 H; (CH_2)$_3$CH$_3$), 1.79 (quin, ^3J(H,H) = 6.8 Hz, 4 H; OCH$_2$CH_2), 4.38 (t, ^3J(H,H) = 6.8 Hz, 4 H; OCH_2), 8.03 (t, ^3J(H,H) = 7.6 Hz, 1 H; Py*H*(*para*)), 8.40 (s, 2 H; C*H* of oxazole), 8.43 (d, ^3J(H,H) = 7.6 Hz, 2 H; Py*H*(*meta*)) ppm. ^{13}C-NMR (125 MHz, $CDCl_3$, TMS): δ = 14.0, 22.5, 25.5, 28.6, 31.4, 65.66, 124.4, 134.9, 138.3, 145.0, 145.5, 160.2, 161.0 ppm. IR (KBr): ν_{max} = 1730 cm^{-1} (νC=O, ester). MS (EI, 70 eV): *m/z* (%): 469 (100) [M^+], 386 (69), 302 (73), 190 (82). Elemental analyses calcd (%) for $C_{25}H_{31}N_3O_6$: C 63.95, H 6.65, N 8.95; found: C 63.90, H 6.54, N 9.17.

Synthesis of Reference 4



Scheme S2. Synthesis of reference **4**. a) $SOCl_2$, reflux, 21 h. b) L-SerOMe·HCl, Et_3N, $CHCl_3$, RT, 1 d, 27% from isophthalic acid. c) Et_2NSF_3, CH_2Cl_2, -78 °C, 4 h; then K_2CO_3, -78 °C → RT, overnight; 84%. d) $BrCCl_3$, DBU, CH_2Cl_2, 0 °C, overnight, 89%. e) KOH, MeOH-H_2O, RT, 3 h then reflux, 1.5 h, 90%. f) $SOCl_2$, reflux, overnight. g) NaN_3, acetone-H_2O, 0 °C, 1 h → RT, 4.5 h. h) $CHCl_3$, reflux, 3 h; then 1-hexanol, $CHCl_3$, reflux, overnight; 16% from **18**.

***N,N'*-(Phenylene-1,3-diyldicarbonyl)bis-L-serine Dimethyl Ester (15):** This compound was obtained from isophthalic acid (3.01 g, 18.1 mmol) by the procedures similar as those for **7**. After purification by column chromatography (silica gel, AcOEt-MeOH = 5:1), the desired product **15** was obtained as a white solid (1.81 g, 27%): mp 152-154 °C (recrystallized from AcOEt). ^{1}H-NMR (500 MHz, $CDCl_3$, TMS): δ = 3.85 (s, 6H; C*H*$_3$), 4.09-4.17 (m, 4 H; C*H*$_2$), 4.88 (m, 2H; C*H*), 7.39 (t, ^3J(H,H) = 7.9 Hz, 1 H; C-5 C*H* of benzene), 7.51 (d, ^3J(H,H) = 7.6 Hz, 1 H; N*H*), 7.90 (d, ^3J(H,H) = 7.9 Hz, 2 H; C-4,6 C*H* of benzene), 8.25 (s, 1 H; C-2 C*H* of benzene) ppm. ^{13}C-NMR (125 MHz, $CDCl_3$, TMS): δ = 53.0, 55.4, 63.2, 125.2, 129.2, 131.0, 133.6, 166.7, 171.2 ppm. IR (KBr): ν_{max} = 3370 (υOH), 1750 and 1740 (νC=O, ester), 1645 and 1635 (νC=O, amide) cm^{-1}. MS (FAB): *m*/*z*: 369 [*M*+H]$^+$. Elemental analyses calcd (%) for $C_{16}H_{20}N_2O_8$: C 52.17, H 5.47, N 7.61; found: C 52.26, H 5.54, N 7.75.

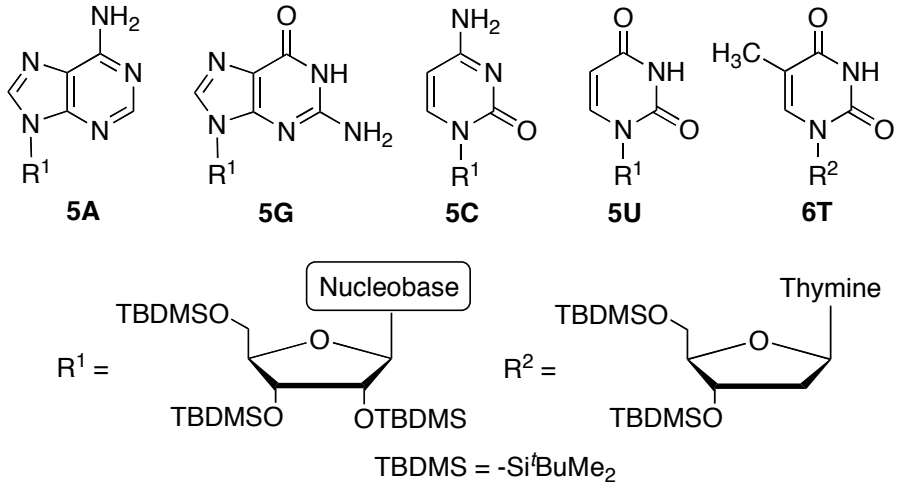
(*S*,*S*)-2,2'-(1,3-Phenylene)bis(4,5-dihydrooxazole-4-carboxylic acid) Dimethyl Ester (16): This compound was obtained from **15** (2.27 g, 6.16 mmol) by the procedures similar as those for **8**. After purification by column chromatography (silica gel, $CHCl_3$-MeOH = 30:1), the desired product **16** was obtained as a white solid (1.72 g, 84%): mp 129-130 °C (recrystallized from AcOEt). ^{1}H-NMR (500 MHz, $CDCl_3$, TMS): δ = 3.83 (s, 6 H; C*H*$_3$), 4.61 (dd, ^2J(H,H) = 10.7, ^3J(H,H) = 8.5 Hz, 2 H; one of C*H*$_2$), 4.71 (br dd, ^3J(H,H) ≈ 8 Hz, 2 H; C*H*), 4.97 (dd, ^2J(H,H) = 10.7, ^3J(H,H) = 7.9 Hz, 2 H; one of C*H*$_2$), 7.48 (t, ^3J(H,H) = 7.9 Hz, 1 H; C-5 C*H* of benzene), 8.13 (d, ^3J(H,H) = 7.9 Hz, 2 H; C-4,6 C*H* of benzene), 8.56 (s, 1 H; C-2 C*H* of benzene) ppm. ^{13}C-NMR (125 MHz, $CDCl_3$, TMS): δ = 52.8, 68.7, 69.7, 127.4, 128.6, 128.8, 131.9, 165.5, 171.4 ppm. IR (KBr): ν_{max} 1740 and 1726 cm^{-1} (νC=O, ester). MS (FAB): *m*/*z*: 333 [*M*+H]$^+$.

2,2'-(1,3-Phenylene)bis(oxazole-4-carboxylic acid) Dimethyl Ester (17): This compound was obtained from **16** (1.28 g, 3.85 mmol) by the procedures similar as those for **9**. After purification by column chromatography (silica gel, $CHCl_3$), the desired product **17** was obtained as a white solid (1.12 g, 89%): mp 194-196 °C (recrystallized from AcOEt). ^{1}H-NMR (500 MHz, $CDCl_3$, TMS): δ = 3.98 (s, 6 H; CH_3), 7.61 (t, ^3J(H,H) = 7.9Hz, 1 H; C-5 C*H* of benzene), 8.27 (d, ^3J(H,H) = 7.9 Hz, 2 H; C-4,6 C*H* of benzene), 8.34 (s, 2 H; C*H* of oxazole), 8.84 (s, 1 H; C-2 C*H* of benzene) ppm. ^{13}C-NMR (125 MHz, $CDCl_3$, TMS): δ = 52.3, 125.1, 127.3, 129.4, 129.6, 134.7, 144.1, 161.5, 161.6 ppm. IR (KBr): ν_{max} = 1740 and 1730 cm^{-1} (νC=O, ester). MS (FAB): *m*/*z*: 329 [*M*+H]$^+$. Elemental analyses calcd (%) for $C_{16}H_{12}N_2O_6$: C 58.54, H 3.68, N 8.53; found: C 58.35, H 3.87, N 8.12.

2,2'-(1,3-Phenylene)bis(oxazole-4-carboxylic acid) (18): This compound was obtained from **17** (0.30 g, 5.5 mmol) by the procedures similar as those for **14**, yielding the desired product **18** as a white solid (0.248 g, 90%): mp 276-287 °C (recrystallized from $CHCl_3$/MeOH). ^{1}H-NMR (500 MHz, [D_6]DMSO, TMS): δ = 7.79 (t, ^3J(H,H) = 7.9 Hz, 1 H; C-5 C*H* of benzene), 8.19 (d, ^3J(H,H) = 7.9 Hz, 2 H; C-4,6 C*H* of benzene), 8.60 (s, 1 H; C-2 C*H* of benzene), 8.92 (s, 2 H; C*H* of oxazole), 13.25 (br s, 2 H; COO*H*) ppm. ^{13}C-NMR (125 MHz, $CDCl_3$, TMS): δ = 123.8, 127.1, 128.5, 130.5, 134.6, 145.8, 160.2, 161.8 ppm. IR (KBr): ν_{max} = 3600~3200 (νOH, carboxy), 1695 (νC=O, ester) cm^{-1}. MS (FAB): *m*/*z*: 307 [*M*+H]$^+$.

2,2'-(1,3-Phenylene)bis(oxazole-4-carbamic acid) Dihexyl Ester (4): This compound was obtained from **18** (0.400 g, 1.33 mmol) by the procedures similar as those for **1**. After purification by column chromatography (alumina, $CHCl_3$-hexane = 1:10), the desired product **4** was obtained as a white solid (0.094 g, 16%): mp 155-156 °C (recrystallized from AcOEt). ^{1}H-NMR (500 MHz, $CDCl_3$, TMS): δ = 0.89 (t, ^3J(H,H) = 6.7 Hz, 6 H; CH_3), 1.31 (m, 12 H; (CH_2)$_3$CH$_3$), 1.66 (m, 4 H; OCH$_2$CH_2), 4.18 (m, 4 H; OCH_2), 7.05 (br s, 2 H; N*H*), 7.54 (t, ^3J(H,H) = 7.9 Hz, 1 H; C-5 C*H* of benzene), 7.91 (s, 2 H; C*H* of oxazole), 8.04 (d, ^3J(H,H) = 7.9 Hz, 2 H; C-4,6 C*H* of benzene), 8.59 (s, 1 H; C-2 C*H* of benzene) ppm. ^{13}C-NMR (125 MHz, $CDCl_3$, TMS): δ = 14.0, 22.5, 25.5, 28.8, 31.4, 66.1, 124.0, 124.6, 127.8, 129.4, 138.3, 153.1, 158.3 ppm. IR (KBr): ν_{max} = 3300, 3150 (νNH, carbamoyl), 1710 (νC=O, carbamoyl) cm^{-1}. MS (FAB): *m*/*z*: 499 [*M*+H]$^+$. Elemental analyses calcd (%) for $C_{26}H_{34}N_4O_6$: C 62.70, H 6.88, N 11.25; found: C 62.40, H 6.82, N 11.48.

Synthesis of Lipophilic Nucleoside Guests. A series of lipophilic nucleoside guests, applicable in organic solvents, were prepared, introducing *tert*-butyldimethylsilyl groups to all hydroxy groups by the reported procedure[S2-S4] with some modifications.



5A = 2',3',5'-tris-*O*-(*tert*-butyldimethylsilyl)adenosine
5G = 2',3',5'-tris-*O*-(*tert*-butyldimethylsilyl)guanosine
5C = 2',3',5'-tris-*O*-(*tert*-butyldimethylsilyl)cytidine
5U = 2',3',5'-tris-*O*-(*tert*-butyldimethylsilyl)uridine
6T = 3',5'-bis-*O*-(*tert*-butyldimethylsilyl)thymidine

Scheme S3. Lipophilic nucleoside guests.

2',3',5'-Tris-*O*-(*tert*-butyldimethylsilyl)adenosine (5A): This compound was prepared from adenosine and *tert*-butyldimethylsilyl chloride (TBDMS-Cl) with imidazole in anhyd DMF by employing the reported procedure[S3] with some modifications. After purification by column chromatography (silica gel, AcOEt-hexane = 1:3), the desired product **5A** was obtained as a white solid (1.84 g, 75%): mp 143-144 °C (recrystallized from hexane) [lit.: mp 142-144 °C[S2b]]. ^{1}H-NMR (400 MHz, $CDCl_3$, TMS): δ = -0.23, -0.04, 0.10, 0.11, 0.13 and 0.14 (six s, each 3 H; SiCH_3 × 6), 0.80, 0.93 and 0.96 (three s, each 9 H; C(CH_3)$_3$ × 3), 3.79 (dd, ^2J(H,H) = 11.5, ^3J(H,H) = 2.9 Hz, 1 H; one of C-5' CH_2), 4.03 (dd, ^2J(H,H) = 11.5, ^3J(H,H) = 4.4 Hz, 1 H; one of C-5' CH_2), 4.13 (ddd, ^3J(H,H) = 2.9, 3.9, 4.4 Hz, 1 H; C-4' C*H*), 4.32 (dd, ^3J(H,H) = 3.9, 4.8 Hz, 1 H; C-3' C*H*), 4.69 (dd, ^3J(H,H) = 4.8, 5.4 Hz, 1 H; C-2' C*H*), 5.50 (s, 2 H; NH_2), 6.03 (d, ^3J(H,H) = 5.4 Hz, 1 H; C-1' C*H*), 8.16 (s, 1 H; C-8 C*H*), 8.34 (s, 1 H; C-2 C*H*) ppm. HRMS (ESI) calcd (*m*/*z*) for $C_{28}H_{55}N_5O_4Si_3$ [*M*+H]$^+$: 610.3640. Found: 610.3631. Elemental analyses calcd (%) for $C_{28}H_{55}N_5O_4Si_3$: C 55.13, H 9.09, N 11.48; found: C 54.91, H 8.94, N 11.32.

2',3',5'-Tris-*O*-(*tert*-butyldimethylsilyl)guanosine (5G): This compound was prepared from guanosine and TBDMS-Cl with imidazole in anhyd DMF by employing the reported procedure[S3] with some modifications. After purification by column chromatography (silica gel, AcOEt-hexane = 1:1), the desired product **5G** was obtained as a white solid (3.300 g, 53%): mp 288-290 °C (recrystallized from hexane) [lit.: > 300 °C (dec),[S3] mp > 245 °C[S5]]. ^{1}H-NMR (400 MHz, $CDCl_3$, TMS): δ = -0.06, 0.01, 0.09, 0.10, 0.13 and 0.14 (six s, each 3 H; SiCH_3 × 6), 0.86, 0.93 and 0.96

(three s, each 9 H; C(CH_3)$_3$ × 3), 3.78 (dd, ^2J(H,H) = 11.5, ^3J(H,H) = 2.4 Hz, 1 H; one of C-5' CH_2), 3.98 (1 H; m, one of C-5' CH_2), 4.10 (m, 1 H; C-4' C*H*), 4.28 (t, ^3J(H,H) = 4.4 Hz, 1 H; C-3' C*H*), 4.35 (m, 1 H; C-2' C*H*), 5.83 (d, ^3J(H,H) = 4.4 Hz, 1 H; C-1' C*H*), 5.97 (br s, 2 H; NH_2), 7.90 (s, 1 H; C-8 C*H*), 12.10 (br s, 1 H; N*H*) ppm. Elemental analyses calcd (%) for $C_{28}H_{55}N_5O_5Si_3$: C 53.72, H 8.86, N 11.19; found: C 53.51, H 8.86, N 11.06.

2',3',5'-Tris-*O*-(*tert*-butyldimethylsilyl)cytidine (5C): This compound was prepared from cytidine and TBDMS-Cl with pyridine, triethylamine and $AgNO_3$ in THF by employing the reported procedure[S4] with some modifications. After purification by column chromatography (silica gel, $CHCl_3$-MeOH = 50:1), the desired product **5C** was obtained as a white solid (2.81 g, 96%): mp 125-126 °C (recrystallized from hexane) [lit.: mp 103-109 °C[S5]]. ^{1}H-NMR (400 MHz, $CDCl_3$, TMS): δ = 0.04 and 0.05 (two s, each 3 H; SiCH_3 × 2), 0.12 (s, 6 H; SiCH_3 × 2), 0.14 and 0.24 (two s, each 3 H; SiCH_3 × 2), 0.88, 0.91 and 0.95 (three s, each 9 H; C(CH_3)$_3$ × 3), 3.77 (br d, ^2J(H,H) = 10.5 Hz, 1 H; one of C-5' CH_2), 4.01~4.12 (m, 4 H; C-2', C-3' and C-4' C*H* plus one of C-5' CH_2), 5.58 (d, ^3J(H,H) = 7.3 Hz, 1 H; C-5 C*H*), 5.78 (d, ^3J(H,H) = 1.5 Hz, 1 H; C-1' C*H*), 8.21 (d, ^3J(H,H) = 7.3 Hz, 1 H; C-6 C*H*) ppm. MS (ESI): *m*/*z*: 586 [*M*+H]$^+$. Elemental analyses calcd (%) for $C_{27}H_{55}N_3O_5Si_3$: C 55.34, H 9.46, N 7.17; found: C 55.19, H 9.43, N 7.31.

2',3',5'-Tris-*O*-(*tert*-butyldimethylsilyl)uridine (5U): This compound was prepared from uridine and TBDMS-Cl with imidazole in anhyd DMF by employing the reported procedure[S2b,S3] with some modifications. After purification by column chromatography (silica gel, AcOEt-hexane = 1:3), the desired product **5U** was obtained as a white hard gum[S2b] (2.13 g, 73%). ^{1}H-NMR (400 MHz, $CDCl_3$, TMS): δ = 0.06, 0.07, 0.08, 0.09, 0.12 and 0.13 (six s, each 3 H; SiCH_3 × 6), 0.89, 0.91 and 0.95 (three s, each 9 H; C(CH_3)$_3$ × 3), 3.75 (br d, ^2J(H,H) = 11.5 Hz, 1 H; one of C-5' CH_2), 3.98 (br d, ^2J(H,H) = 11.5 Hz, 1 H; one of C-5' CH_2), 4.07~4.09 (m, 3 H; C-2', C-3' and C-4' C*H*), 5.67 (dd, ^3J(H,H) = 3.7, 8.0 Hz, 1 H; C-5 C*H*), 5.88 (d, ^3J(H,H) = 3.7 Hz, 1 H; C-1' C*H*), 8.01 (d, ^3J(H,H) = 8.0 Hz, 1 H; C-6 C*H*), 8.08 (br s, 1 H; N*H*) ppm. MS (FAB): *m*/*z*: 587 [*M*+H]$^+$. Elemental analyses calcd (%) for $C_{27}H_{54}N_2O_6Si_3$: C 55.25, H 9.27, N 4.77; found: C 54.99, H 9.46, N 4.71.

3',5'-Bis-*O*-(*tert*-butyldimethylsilyl)thymidine (6T): This compound was prepared from thymidine and TBDMS-Cl with imidazole in anhyd DMF by employing the reported procedure.[S2b,S3] After purification by column chromatography (silica gel, AcOEt-hexane = 1:3), the desired product **6T** was obtained as a white solid (2.16 g, 92%): mp 144 °C (recrystallized from hexane) [lit.: mp 144-145 °C[S2a]]. ^{1}H-NMR (400 MHz, $CDCl_3$, TMS): δ = 0.077 and 0.084 (two s, each 3 H; SiCH_3 × 2), 0.12 (s, 6 H; SiCH_3 × 2), 0.90 and 0.93 (two s, each 9 H; C(CH_3)$_3$ × 2), 1.92 (s, 3 H; ArCH_3), 2.00 (m, 1 H; one of C-2' CH_2), 2.25 (m, 1 H; one of C-2' CH_2), 3.76 (dd, ^2J(H,H) = 11.7, ^3J(H,H) = 2.4 Hz, 1 H; one of C-5' CH_2), 3.87 (dd, ^2J(H,H) = 11.7, ^3J(H,H) = 2.4 Hz, 1 H; one of C-5' CH_2), 3.94 (m, 1 H; C-4' C*H*), 4.41 (m, 1 H; C-3' C*H*), 6.33 (dd, ^3J(H,H) = 5.9, 8.1 Hz, 1 H; C-1' C*H*), 7.47 (s, 1 H; C-6 C*H*), 7.95 (br s, 1 H; N*H*) ppm. MS (FAB): *m*/*z*: 471 [*M*+H]$^+$. Elemental analyses calcd (%) for $C_{22}H_{42}N_2O_5Si_2$: C 56.13, H 8.99, N 5.95; found: C 56.27, H 9.21, N 6.21.

II. ^{1}H-NMR Measurements

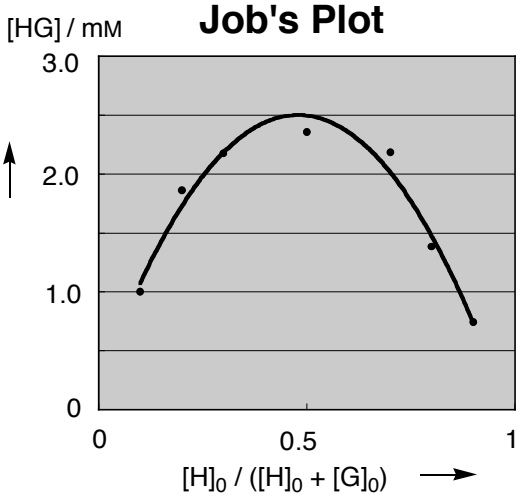


Figure S1. Job's plot for the complex of host **1** and guest **5A**, obtained by ^{1}H-NMR measurements (400 MHz) in $CDCl_3$ at 27 °C. [Host **1**]$_0$ + [Guest **5A**]$_0$ = 10.0 mM; solvent, $CDCl_3$; temperature, 27 °C. The concentration of the host-guest complex ([HG]) was estimated from $\Delta\delta_{obsd}$ for the $NHCO_2CH_2$ signal of host **1**, according to the equation, $[HG] = (\delta_{obsd} - \delta_H)[H]_0 / (\delta_{HG} - \delta_H)$.

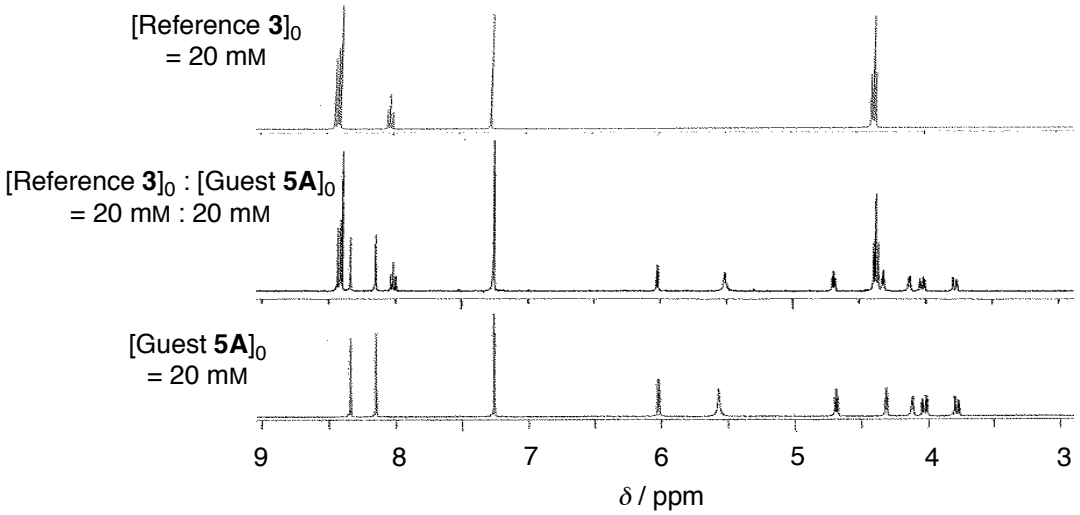


Figure S2. ^{1}H-NMR spectra (400 MHz) of reference **3** and/or guest **5A** in $CDCl_3$. [Reference **3**]$_0$ = 0 or 20 mM; [guest **5A**]$_0$ = 0 or 20 mM. Measured at 23 °C, using $CHCl_3$ as the internal standard (δ = 7.26 ppm).

Negligible changes in the chemical shifts of both host and guest indicate negligible host-guest complexation.

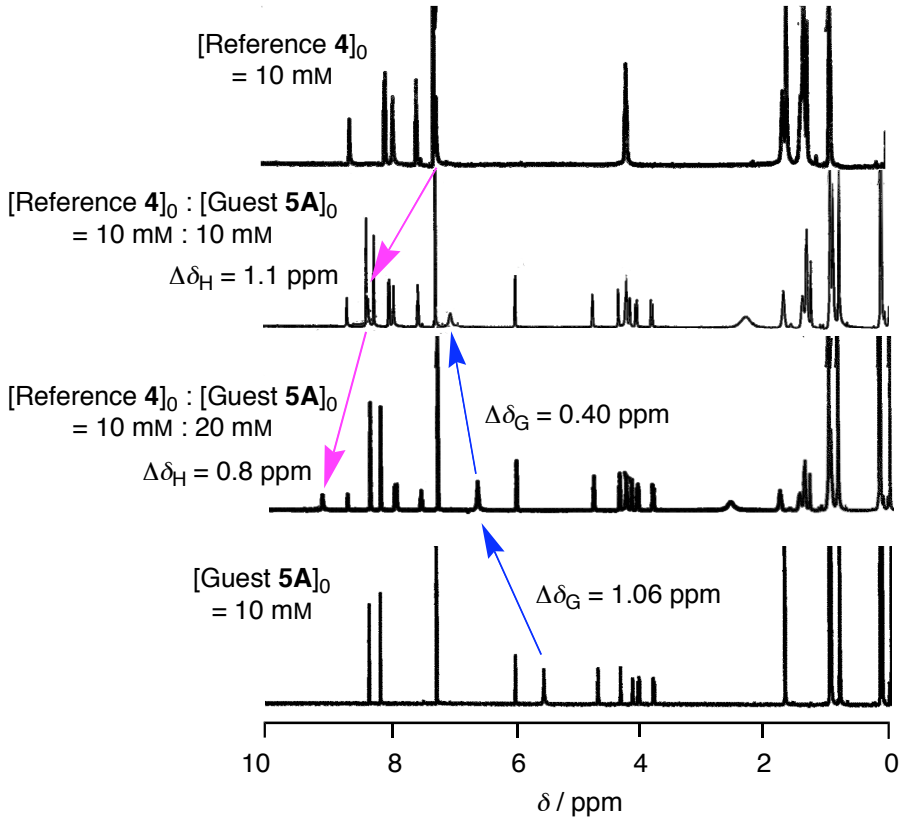


Figure S3. ^{1}H-NMR spectra (500 MHz) of reference **4** and/or guest **5A** in $CDCl_3$. [Reference **4**]$_0$ = 0 or 10 mM; [guest **5A**]$_0$ = 0, 10 or 20 mM. Measured at *ca.* 25 °C using TMS as the external standard.

A moderate degree of host-guest complexation by hydrogen bonding is supported by guest-induced downfield shift of the carbamoyl NH signal of the host (purple arrows) and also by host-induced downfield shift of the NH_2 signal of the guest (blue arrows).

III. Fluorescence Measurements

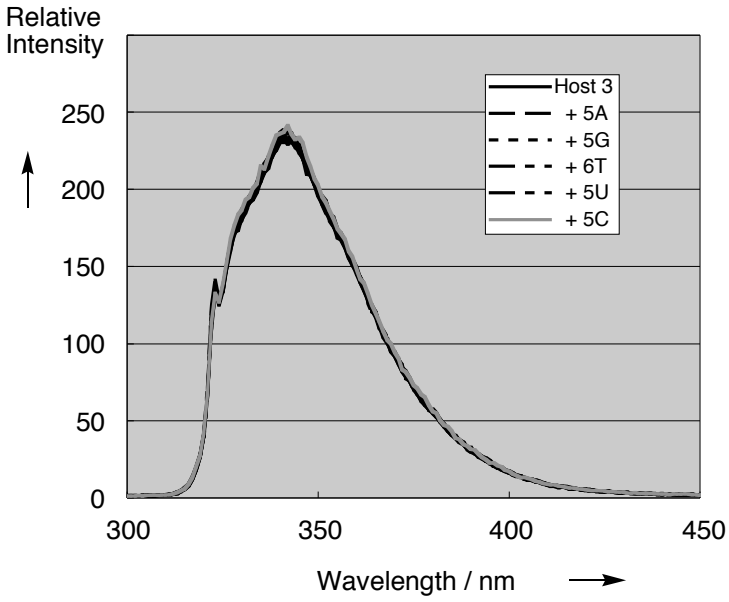


Figure S4. Fluorescence spectra of reference **3** in the presence of nucleoside guests (**5A**, **5G**, **5C**, **5U** or **6T**). [Reference **3**]$_0$ = 20 μM; [guest **5A**, **5G**, **5C**, **5U** or **6T**]$_0$ = 200 μM. λ_{ex} = 320 nm;

solvent, $CHCl_3$; temperature, 20 °C. The ordinate indicates relative fluorescence intensity.

Guest-induced change of the fluorescence of host **3** is negligible in the presence of a large excess of the guest, indicating negligible host-guest complexation.

Determination of the Stability Constants of Host-Guest Complexes:

Stability constants of 1:1 complexes (K_s [M^{-1}]) were determined by the Benesi-Hildebrand analysis using the KaleidaGraph program. The condition: [**1**] = 20 μM, [**5A**] = 240~580 μM, [**5G**, **5C**, **5U**, or **5T**] = 4.0~16.0 mM. [**2**] = 20 μM, [**5A**] = 240~580 μM, [**5C**] = 0.80~1.6 mM, [**5G**, **5U**, or **5T**] = 4.0~16.0 mM. [**4**] = 20 μM, [**5A**] = 2.0~12.0 mM. Fluorescence emission at 380 nm (host **1**), 371 nm (host **2**) or 376 nm (reference **4**) was measured in $CHCl_3$ at 20 °C with excitation at 336 nm (host **1** with all guests), 326 nm (host **2** with all guests) or 312 nm (reference **4** with guest **5A**).

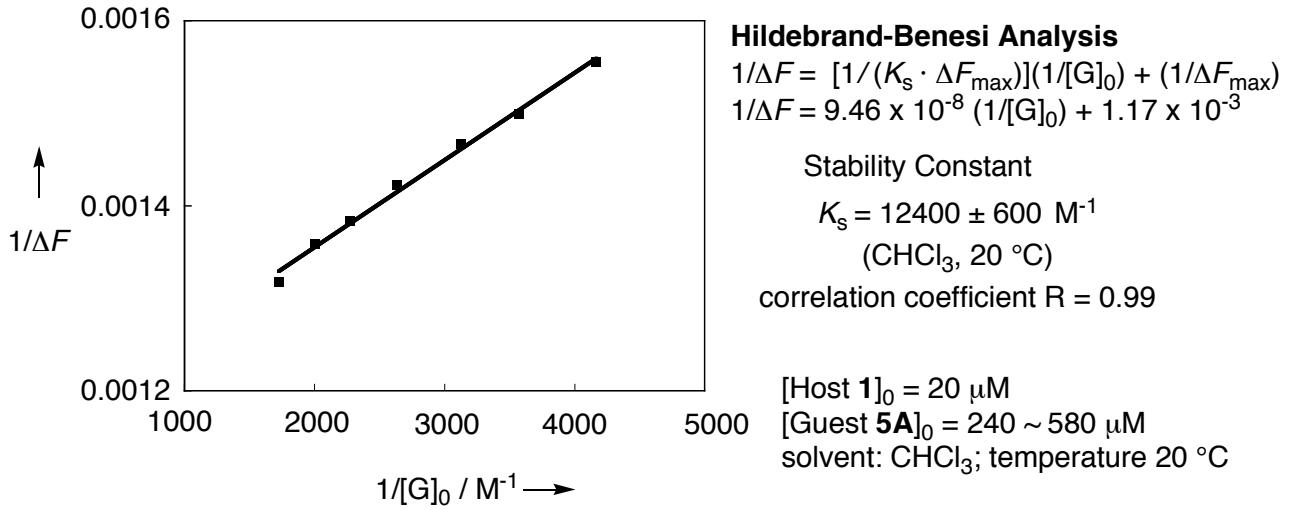
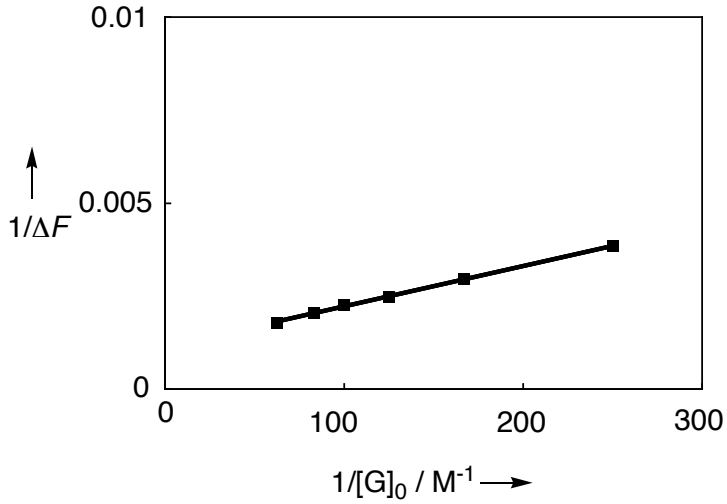


Figure S5. Determination of stability constant (K_s [M^{-1}]) for the 1:1 complex of host **1** and guest **5A** from the fluorescence intensity changes (380 nm).



Hildebrand-Benesi Analysis

$1/\Delta F = [1/(K_s \cdot \Delta F_{max})](1/[G]_0) + (1/\Delta F_{max})$

$1/\Delta F = 1.09 \times 10^{-5} (1/[G]_0) + 1.14 \times 10^{-3}$

Stability Constant

$K_s = 104 \pm 6\ M^{-1}$

($CHCl_3$, 20 °C)

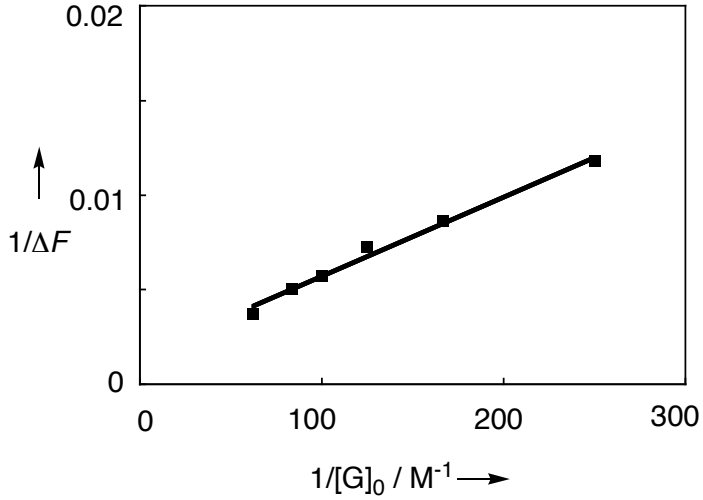
correlation coefficient R = 0.99

$[\text{Host } \mathbf{1}]_0 = 20\ \mu M$

$[\text{Guest } \mathbf{5C}]_0 = 4.0 \sim 16.0$ mM

solvent: $CHCl_3$; temperature 20 °C

Figure S6. Determination of stability constant (K_s [M^{-1}]) for the 1:1 complex of host **1** and guest **5G** from the fluorescence intensity changes (380 nm).



Hildebrand-Benesi Analysis

$1/\Delta F = [1/(K_s \cdot \Delta F_{max})](1/[G]_0) + (1/\Delta F_{max})$

$1/\Delta F = 4.19 \times 10^{-5} (1/[G]_0) + 1.53 \times 10^{-3}$

Stability Constant

$K_s = 37 \pm 10\ M^{-1}$

($CHCl_3$, 20 °C)

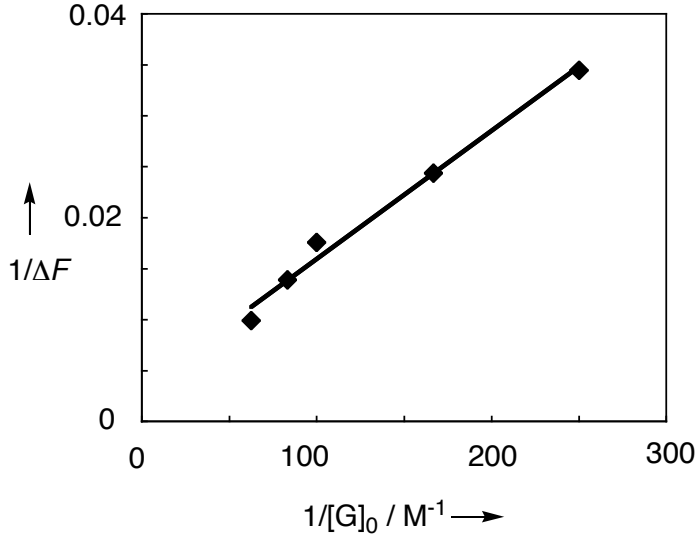
correlation coefficient R = 0.99

$[\text{Host } \mathbf{1}]_0 = 20\ \mu M$

$[\text{Guest } \mathbf{5G}]_0 = 4.0 \sim 16.0$ mM

solvent: $CHCl_3$; temperature 20 °C

Figure S7. Determination of stability constant (K_s [M^{-1}]) for the 1:1 complex of host **1** and guest **5C** from the fluorescence intensity changes (380 nm).



Hildebrand-Benesi Analysis

$1/\Delta F = [1/(K_s \cdot \Delta F_{max})](1/[G]_0) + (1/\Delta F_{max})$

$1/\Delta F = 1.26 \times 10^{-4} (1/[G]_0) + 3.36 \times 10^{-3}$

Stability Constant

$K_s = 27 \pm 11\ M^{-1}$

($CHCl_3$, 20 °C)

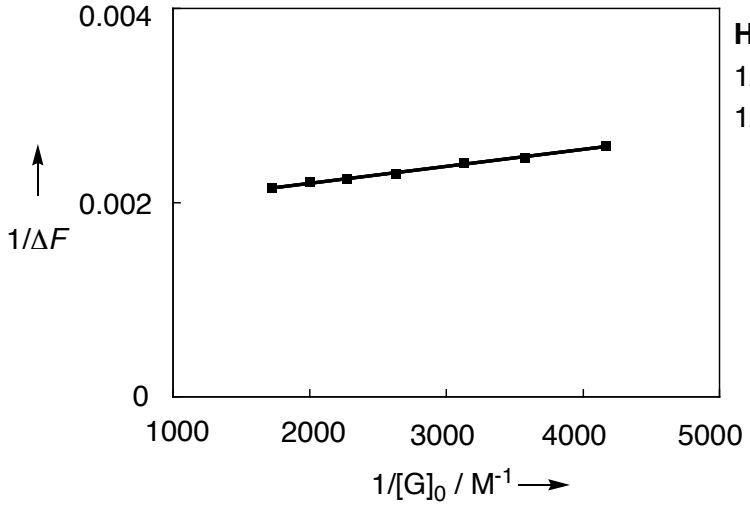
correlation coefficient R = 0.99

$[\text{Host } \mathbf{1}]_0 = 20\ \mu M$

$[\text{Guest } \mathbf{6T}]_0 = 4.0 \sim 16.0$ mM

solvent: $CHCl_3$; temperature 20 °C

Figure S8. Determination of stability constant (K_s [M^{-1}]) for the 1:1 complex of host **1** and guest **6T** from the fluorescence intensity changes (380 nm).



Hildebrand-Benesi Analysis

$1/\Delta F = [1/(K_s \cdot \Delta F_{max})](1/[G]_0) + (1/\Delta F_{max})$

$1/\Delta F = 1.75 \times 10^{-7} (1/[G]_0) + 1.85 \times 10^{-3}$

Stability Constant

$K_s = 10500 \pm 400\ M^{-1}$

($CHCl_3$, 20 °C)

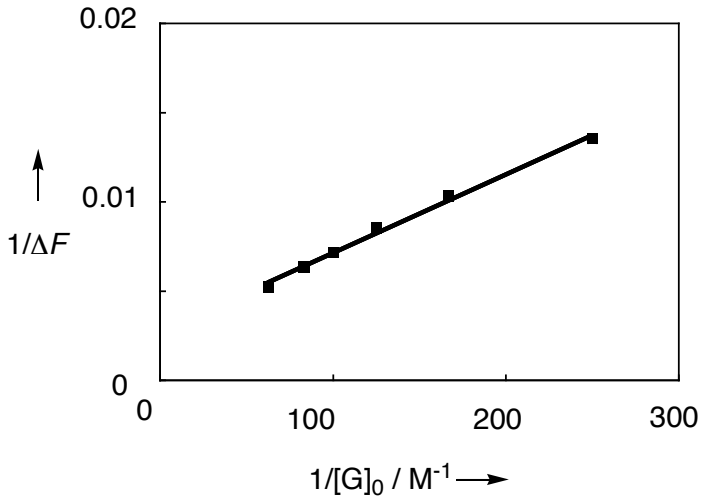
correlation coefficient R = 0.99

[Host **2**]$_0$ = 20 μM

[Guest **5A**]$_0$ = 240 ~ 580 μM

solvent: $CHCl_3$; temperature 20 °C

Figure S9. Determination of stability constant (K_s [M^{-1}]) for the 1:1 complex of host **2** and guest **5A** from the fluorescence intensity changes (371 nm).



Hildebrand-Benesi Analysis

$1/\Delta F = [1/(K_s \cdot \Delta F_{max})](1/[G]_0) + (1/\Delta F_{max})$

$1/\Delta F = 4.41 \times 10^{-5} (1/[G]_0) + 2.71 \times 10^{-3}$

Stability Constant

$K_s = 62 \pm 8\ M^{-1}$

($CHCl_3$, 20 °C)

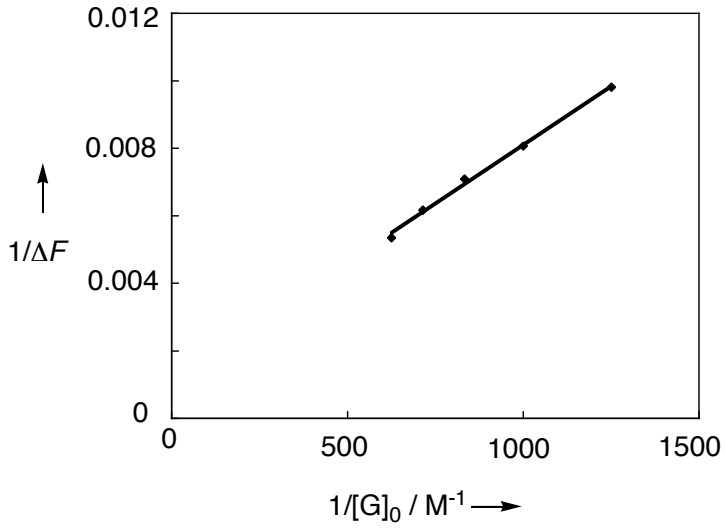
correlation coefficient R = 0.99

[Host **2**]$_0$ = 20 μM

[Guest **5G**]$_0$ = 4.0 ~ 16.0 mM

solvent: $CHCl_3$; temperature 20 °C

Figure S10. Determination of stability constant (K_s [M^{-1}]) for the 1:1 complex of host **2** and guest **5G** from the fluorescence intensity changes (371 nm).



Hildebrand-Benesi Analysis

$1/\Delta F = [1/(K_s \cdot \Delta F_{max})](1/[G]_0) + (1/\Delta F_{max})$

$1/\Delta F = 6.97 \times 10^{-6} (1/[G]_0) + 1.14 \times 10^{-3}$

Stability Constant

$K_s = 163 \pm 40\ M^{-1}$

($CHCl_3$, 20 °C)

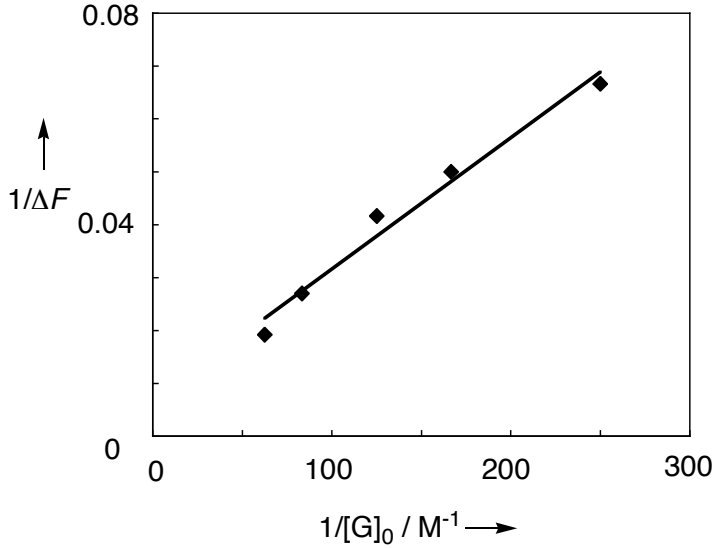
correlation coefficient R = 0.99

[Host **2**]$_0$ = 20 μM

[Guest **5C**]$_0$ = 0.80 ~ 1.6 mM

solvent: $CHCl_3$; temperature 20 °C

Figure S11. Determination of stability constant (K_s [M^{-1}]) for the 1:1 complex of host **2** and guest **5C** from the fluorescence intensity changes (371 nm).



Hildebrand-Benesi Analysis

$1/\Delta F = [1/(K_s \cdot \Delta F_{max})](1/[G]_0) + (1/\Delta F_{max})$

$1/\Delta F = 2.49 \times 10^{-4} (1/[G]_0) + 6.66 \times 10^{-3}$

Stability Constant

$K_s = 27 \pm 16\ M^{-1}$

($CHCl_3$, 20 °C)

correlation coefficient R = 0.99

[Host **2**]$_0$ = 20 μM

[Guest **6T**]$_0$ = 4.0 ~ 16.0 mM

solvent: $CHCl_3$; temperature 20 °C

Figure S12. Determination of stability constant (K_s [M^{-1}]) for the 1:1 complex of host **2** and guest **6T** from the fluorescence intensity changes (371 nm).

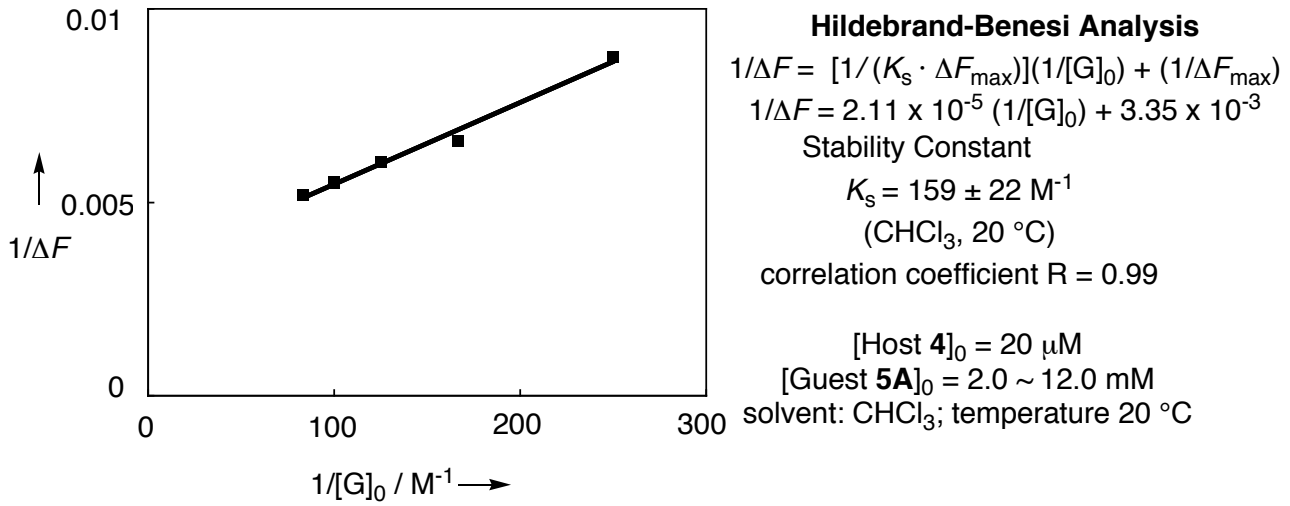


Figure S13. Determination of stability constant (K_s [M^{-1}]) for the 1:1 complex of reference **4** and guest **5A** from the fluorescence intensity changes (376 nm).

IV. UV-Vis Spectrophotometric Measurements

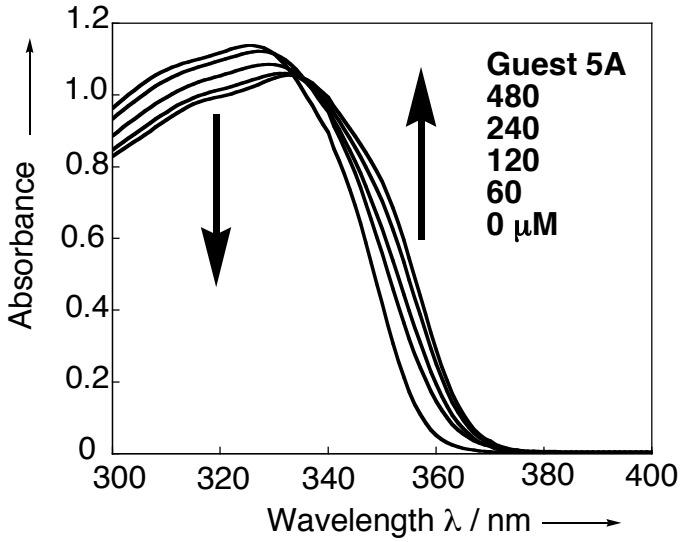
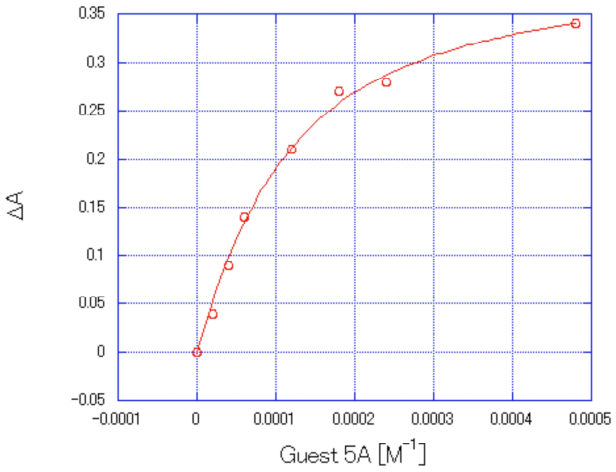


Figure S14. UV-Vis absorption spectra of host **1** with increasing concentration of adenosine guest 5A. The condition: [**1**] = 60 μM, [**5A**] = 60~480 μM; solvent, $CHCl_3$; temperature, 20 °C.



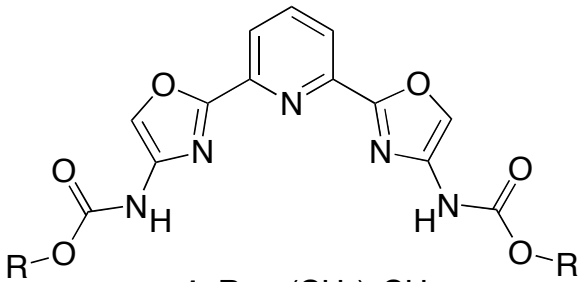
Stability Constant
K_s = 12300 ± 1600 M^{-1}
($CHCl_3$, 20 °C)
correlation coefficient R = 0.99

[Host **1**]$_0$ = 60 μM
[Guest **5A**]$_0$ = 20 ~ 480 μM
solvent: $CHCl_3$; temperature 20 °C

Figure S15. Determination of stability constant (K_s [M^{-1}]) for the 1: 1 complex of host **1** and guest **5A** from the absorbance changes (350 nm) by the nonlinear least-square curve fitting method using the KaleidaGraph program.

V. Calculation of the Optimized Structure and Energy of Host-Guest Complex

Model Complex of Host 1' (R = CH_3) and 9-Methyladenine. The optimized structure was obtained by the non-empirical molecular orbital calculation (see footnote 18 of the text).



1: R = -$(CH_2)_5CH_3$
1': R = -CH_3

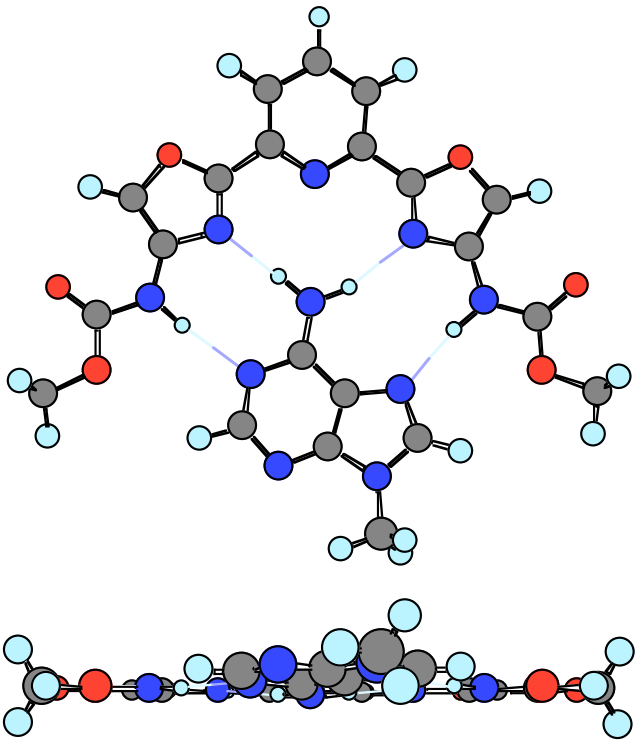


Figure S16. The optimized structure of the model complex of host **1**' (R = CH_3) and 9-methyladenine.

Top view: The N-H···N distances in the model complex of host **1'** and 9-methyladenine (2.06, 1.90, 2.04 and 1.97 Å from left to right), which are much shorter than the van der Waals distance (*ca*. 2.4 Å), suggest the formation of four hydrogen bonds (blue lines) with adenine nucleobase in the complex by host **1**. On the other hand, the distances between the pyridine nitrogen of host **1'** and the NH_2 hydrogens of the guest is found to be much longer (2.92 and 2.69 Å), indicating that the pyridine nitrogen in host **1** does not contribute as a hydrogen bonding acceptor. Lateral view: Completely planar structure of the host-guest complex.

Table S1. Atomic coordinates for the optimized structure of the model complex of host **1**' (R = CH_3) and 9-methyladenine.[a]

Center number	Atomic number	Coordinates (Å) X	Y	Z
1	6	.894421	-2.416617	-.000690
2	6	.682859	-3.785253	.149146
3	7	2.250534	-2.129981	-.012231
4	6	-.262307	-1.598869	-.103971
5	7	-.499493	-4.419756	.206192
6	7	1.944245	-4.345681	.231886
7	6	2.234579	-5.761126	.395029
8	7	-1.474223	-2.222258	-.049021
9	7	-.206609	-.279340	-.260287
10	6	-1.512180	-3.556991	.098708
11	6	2.832683	-3.301114	.127618
12	1	2.827005	-5.932934	1.299036
13	1	2.775120	-6.152038	-.472856
14	1	1.278856	-6.280088	.486238
15	1	-1.066317	.270836	-.221580
16	1	.668400	.237356	-.199486
17	1	-2.512704	-3.983812	.135820
18	1	3.903400	-3.453004	.160680
19	7	2.071314	1.709578	-.036150
20	6	3.443834	1.580391	-.048322
21	6	1.848057	2.996296	.020296
22	7	3.997942	.311537	-.102139
23	6	4.014446	2.822948	.000895
24	7	-2.716938	1.188626	-.035601
25	8	2.981450	3.733986	.045746
26	6	-2.843204	2.483456	.038213
27	6	5.348941	.114135	-.133382
28	6	-3.996600	.687399	-.031473
29	7	-4.150830	-.686316	-.096572
30	8	-4.130545	2.890116	.089012
31	6	-4.881493	1.729094	.043926
32	8	6.194157	.992868	-.127795
33	7	-.521415	2.888243	.028576
34	6	.552213	3.684277	.064639
35	6	-1.738831	3.446650	.074621

(to be continued)

Center number	Atomic number	Coordinates (Å) X	Y	Z
36	6	.457826	5.083715	.145823
37	6	-1.940055	4.832015	.155793
38	6	-.813243	5.652020	.190491
39	6	-5.380244	-1.283457	-.112221
40	8	-5.240989	-2.631054	-.168512
41	8	-6.447990	-.695217	-.082184
42	8	5.628617	-1.216296	-.173767
43	6	7.028524	-1.523692	-.225952
44	6	-6.475904	-3.358733	-.201302
45	1	3.358493	-.499756	-.097747
46	1	5.020216	3.199450	.008467
47	1	-3.286250	-1.252182	-.108927
48	1	-5.951331	1.821279	.071932
49	1	1.352866	5.694866	.173367
50	1	-2.943341	5.242273	.190898
51	1	-.925651	6.730498	.253477
52	1	7.085427	-2.611850	-.277666
53	1	7.540205	-1.157083	.668041
54	1	7.491449	-1.075710	-1.109121
55	1	-7.075285	-3.065917	-1.067503
56	1	-7.054999	-3.180290	.708932
57	1	-6.190769	-4.408941	-.271903

[a] B3LYP/6-31G* optimized cartesian coordinates are listed. The total electronic energy (HF) was calculated to be -1811.2211576 hartree.

VI. Potentiometric Measurements

Reagents: The following compounds were of the highest grade commercially available and used without further purification: Tridodecylmethylammonium chloride (TDDMACl; catalog number 91661) and poly(vinyl chloride) (PVC, high molecular weight; 81392) from Fluka (Buchs, Switzerland); *o*-nitrophenyl octyl ether (NPOE; 347-04522) from Dojindo Laboratories (Kumamoto, Japan); adenosine 5'-monophosphate (5'-AMP, disodium salt; 302-50743) and cytidine 5'-monophosphate (5'-CMP, disodium salt; 030-05363) from Wako Pure Chemical (Osaka, Japan); guanosine 5'-monophosphate (5'-GMP, disodium salt; G-8377) and uridine 5'-monophosphate (5'-UMP, disodium salt; U-6375 from Sigma-Aldrich (St. Louis, USA).

[S1] F. Yokokawa, Y. Hamada, T. Shioiri, *Synlett* **1992**, 151-152.

[S2] a) Ogilvie, K. K. *Can. J. Chem.* **1973**, *51*, 3799-3807; b) K. K. Ogilvie, S. L. Beaucage, A. L. Schifman, N. Y. Theriault, K. L. Sadana, *Can. J. Chem.* **1978**, *56*, 2768-2780.

[S3] C. Sheu, P. Kang, S. Khan, C. S. Foote, *J. Am. Chem. Soc.* **2002**, *124*, 3905-3913

[S4] K. Y. Jung, R. J. Hohl, A. J. Wiemer, D. F. Wiemer, *Bioorg. Med. Chem.* **2000**, *8*, 2501-2509.

[S5] K. K. Ogilvie, A. L. Schifman, C. L. Penney, *Can. J. Chem.* **1979**, *57*, 2230-2238.