Supporting Information

A Thermodynamic Insight into the Recognition of Hydrophilic and Hydrophobic Amino Acids in Pure Water by Aza-scorpiand Type Receptors

Salvador Blasco, Begoña Verdejo, Carla Bazzicalupi, Antonio Bianchi, Claudia Giorgi, Concepción Soriano, Enrique García-España.

- **Table S1** Thermodynamic data for the formation of amino acid complexes with **L1** in 0.15 M $NaClO_4$ at 298.1 K.

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- **Table S3** Thermodynamic data for the protonation of amino acids in 0.15 M $NaClO_4$, 298.1 K

- **Fig. S1.** Aromatic zone ^1H NMR spectra of solutions containing **L2** and Glu in 1:4 molar ratio recorded in D_2O at pD = 4.5 (a) and pD = 7.3 (b)

- **Fig. S2** Minimum energy structures calculated for the complexes [H**L1**(Asp)]$^-$ (a), [H**L1**(HAsp)] (b), [H_2**L1**(HAsp)]$^+$ (c), [H_3**L1**(HAsp)]$^{2+}$ (d), [H_3**L1**(H_2Asp)]$^{3+}$ (e).

- **Fig. S3**. Minimum energy structures calculated for the complexes [H**L1**(HAla)]$^+$ (a), [H_2**L1**(HAla)]$^{2+}$ (b), [H_3L(HAla)]$^{3+}$ (c).

- **Fig.S4**. Minimum energy structures calculated for the complexes [H**L1**(Trp)] (a), [H**L1**(HTrp)]$^+$ (b), [H_2**L1**(HTrp)]$^{2+}$ (c), [H_3**L1**(HTrp)]$^{3+}$ (d).

- **Fig. S5**. Minimum energy structures calculated for the complexes [H**L1**(His)] (a), [H_2**L1**(His)]$^+$ (b), [H_2**L1**(HHis)]$^{2+}$ (c), [H_3**L1**(HHis)]$^{3+}$ (d), [H_3**L1**(H_2His)]$^{4+}$ (e).

- **Fig. S6**. Minimum energy structures calculated for the complexes [H**L1**(Phe)] (a), [H_2**L1**(Phe)]$^+$ (b), H_2**L1**(HPhe)]$^{2+}$ (c), [H_3**L1**(HPhe)]$^{3+}$ (d).

- **Fig. S7.** Minimum energy structures calculated for the complexes [**L2**(Ala)]$^{-}$ (a), [H**L2**(Ala)] (b), [**L2**(HAla)] (c), [H**L2**(HAla)]$^{+}$ (d), [H_2**L2**(HAla)]$^{2+}$ (e).

Table S1 Thermodynamic data for the formation of amino acid complexes with **L1** in 0.15 M $NaClO_4$ at 298.1 K.

Reaction	log*K*	$\Delta H°$ (kcal/mol)	$T\Delta S°$ (kcal/mol)
$HL^{+} + HAla \rightleftharpoons [HL(HAla)]^{+}$	3.15(4)[a]	-0.1(2)	4.2(2)
$H_2L^{2+} + HAla \rightleftharpoons [H_2L(HAla)]^{2+}$	2.94(5)	-0.1(2)	3.9(2)
$H_3L^{3+} + HAla \rightleftharpoons [H_3L(HAla)]^{3+}$	3.31(4)	0.9(2)	5.4(2)
$HL^{+} + Phe^{-} \rightleftharpoons [HL(Phe)]$	2.81(2)	3.8(2)	7.7(2)
$H_2L^{2+} + Phe^{-} \rightleftharpoons [H_2L(Phe)]^{+}$	3.08(2)	3.4(2)	8.0(2)
$H_2L^{2+} + HPhe \rightleftharpoons H_2L(HPhe)]^{2+}$	2.84(2)	2.3(1)	6.2(1)
$H_3L^{3+} + HPhe \rightleftharpoons [H_3L(HPhe)]^{3+}$	2.87(2)	3.0(2)	6.9(2)
$HL^{+} + Tyr^{2-} \rightleftharpoons [HL(Tyr)]^{-}$	3.27(1)	9.0(4)	13.5(4)
$HL^{+} + HTyr^{-} \rightleftharpoons [HL(HTyr)]$	3.61(1)	5.0(3)	9.9(3)
$H_2L^{2+} + HTyr^{-} \rightleftharpoons [H_2L(HTyr)]^{+}$	3.79(1)	7.2(4)	12.3(4)
$H_2L^{2+} + H_2Tyr \rightleftharpoons [H_2L(H_2Tyr)]^{2+}$	3.31(1)	6.2(3)	10.7(3)
$H_3L^{3+} + H_2Tyr \rightleftharpoons [H_3L(H_2Tyr)]^{3+}$	3.39(1)	7.0(4)	11.6(4)
$HL^{+} + Trp^{-} \rightleftharpoons [HL(Trp)]$	2.83(3)	3.8(2)	7.7(2)
$HL^{+} + HTrp \rightleftharpoons [HL(HTrp)]^{+}$	3.30(2)	1.1(2)	5.6(2)
$H_2L^{2+} + HTrp \rightleftharpoons [H_2L(HTrp)]^{2+}$	3.22(2)	1.5(2)	5.9(2)
$H_3L^{3+} + HTrp \rightleftharpoons [H_3L(HTrp)]^{3+}$	3.42(2)	2.1(2)	6.8(2)
$HL^{+} + Asp^{2-} \rightleftharpoons [HL(Asp)]^{-}$	3.2(1)	5.1(2)	9.5(2)
$HL^{+} + HAsp^{-} \rightleftharpoons [HL(HAsp)]$	3.48(6)	3.4(2)	8.2(2)
$H_2L^{2+} + HAsp^{-} \rightleftharpoons [H_2L(HAsp)]^{+}$	3.47(6)	4.1(2)	8.9(2)
$H_3L^{3+} + HAsp^{-} \rightleftharpoons [H_3L(HAsp)]^{2+}$	3.72(6)	4.6(2)	8.3(2)
$H_3L^{3+} + H_2Asp \rightleftharpoons [H_3L(H_2Asp)]^{3+}$	4.26(6)	4.3(2)	10.2(2)
$HL^{+} + Glu^{2-} \rightleftharpoons [HL(Glu)]^{-}$	3.27(6)	6.0(3)	10.5(3)
$HL^{+} + HGlu^{-} \rightleftharpoons [HL(HGlu)]$	3.66(3)	3.1(2)	8.1(2)
$H_2L^{2+} + HGlu^{-} \rightleftharpoons [H_2L(HGlu)]^{+}$	3.67(4)	4.1(2)	9.1(2)
$H_3L^{3+} + HGlu^{-} \rightleftharpoons [H_2L(H_2Glu)]^{2+}$	3.91(3)	4.6(2)	9.9(2)
$H_3L^{3+} + H_2Glu \rightleftharpoons [H_3L(H_2Glu)]^{3+}$	4.42(4)	1.1(2)	7.1(2)
$HL^{+} + His^{-} \rightleftharpoons [HL(His)]$	2.97(3)	-3.0(2)	1.1(2)
$H_2L^{2+} + His^{-} \rightleftharpoons [H_2L(His)]^{+}$	3.33(2)	1.8(1)	5.1(1)
$H_2L^{2+} + HHis \rightleftharpoons [H_2L(HHis)]^{2+}$	3.12(3)	-1.3(2)	3.0(2)
$H_3L^{3+} + HHis \rightleftharpoons [H_3L(HHis)]^{3+}$	3.38(2)	-1.1(1)	3.5(1)
$H_3L^{3+} + H_2His^{+} \rightleftharpoons [H_3L(H_2His)]^{4+}$	3.79(2)	-5.5(1)	-0.3(1)

[a] Numbers in parentheses are standard deviations in the last significant figure

Table S2 Stepwise stability constants for the formation of selected amino acid complexes with **L2** in 0.15 M $NaClO_4$ at 298.1 K.

Reaction	Ala	Phe	Trp	Tyr	His	Asp	Glu
$L + A^{2-} \rightleftharpoons [LA]^{2-}$	-	-	-	3.11(3)	-	4.09(1)	4.68(2)
$L + A^{-} \rightleftharpoons [LA]^{-}$	3.11(5)[a]	2.62(4)	3.26(3)	-	3.46(4)	-	-
$L + HA^{-} \rightleftharpoons [L(HA)]^{-}$	-	-	-	3.25(5)	-	4.28(2)	4.98(2)
$HL^{+} + A^{2-} \rightleftharpoons [HLA]^{-}$	-	-	-	3.17(5)	-	3.92(2)	4.44(2)
$L + HA \rightleftharpoons [L(HA)]$	3.33(8)	3.0(1)	3.92(3)	-	4.25(4)	-	-
$HL^{+} + A^{-} \rightleftharpoons [HLA]$	3.05(8)	2.0(1)	3.20(3)	-	3.40(4)	-	-
$HL^{+} + HA^{-} \rightleftharpoons [HL(HA)]$	-	-	-	3.30(2)	-	3.79(1)	4.38(2)
$HL^{+} + HA \rightleftharpoons [HL(HA)]^{+}$	3.01(6)	2.27(9)	3.03(4)	-	4.06(5)	-	-
$H_2L^{2+} + HA^{-} \rightleftharpoons [H_2L(HA)]^{+}$	-	-	-	3.29(5)	-	3.29(2)	3.83(2)
$H_2L^{2+} + HA \rightleftharpoons [H_2L(HA)]^{2+}$	2.5(1)	-	2.42(6)	-	2.80(6)	-	-
$H_3L^{3+} + HA^{-} \rightleftharpoons [H_3L(HA)]^{2+}$	-	-	-	-	-	2.38(3)	2.98(2)

[a] Numbers in parentheses are standard deviations in the last significant figure

Table S3 Thermodynamic data for the protonation of amino acids in 0.15 M $NaClO_4$, 298.1 K

Reaction	logK	ΔH° (kcal/mol)	TΔS° (kcal/mol)
$Ala^- + H^+ \rightleftharpoons HAla$	9.73(1)	-10.2(1)	3.1(1)
$HAla + H^+ \rightleftharpoons H_2Ala^+$	2.48(1)	0.0(2)	3.4(2)
$Phe^- + H^+ \rightleftharpoons HPhe$	9.08(1)	-10.28(1)	2.11(3)
$HPhe + H^+ \rightleftharpoons H_2Phe^+$	2.35(1)	-0.59(6)	2.62(6)
$Tyr^{2-} + H^+ \rightleftharpoons HTyr^-$	9.93(1)	-7.1(1)	6.4(1)
$HTyr^- + H^+ \rightleftharpoons H_2Tyr$	9.24(1)	-9.2(1)	3.4(1)
$H_2Tyr + H^+ \rightleftharpoons H_3Tyr^+$	2.48(1)	-0.2(1)	4.0(1)
$Trp^- + H^+ \rightleftharpoons HTrp$	9.27(1)	-9.8(1)	2.8(3)
$HTrp + H^+ \rightleftharpoons H_2Trp^+$	2.46(1)	-0.2(6)	3.1(6)
$Asp^{2-} + H^+ \rightleftharpoons HAsp^-$	9.65(1)	-9.56(7)	3.60(7)
$HAsp^- + H^+ \rightleftharpoons H_2Asp$	3.82(1)	-1.10(6)	4.11(6)
$H_2Asp + H^+ \rightleftharpoons H_3Asp^+$	1.53(1)	1.67(8)	0.42(8)
$Glu^{2-} + H^+ \rightleftharpoons HGlu^-$	9.47 (1)	-9.07(9)	3.85(9)
$HGlu^- + H^+ \rightleftharpoons H_2Glu$	4.20(1)	-0.1(1)	5.6(1)
$H_2Glu + H^+ \rightleftharpoons H_3Glu^+$	2.31(1)	2.0(2)	5.1(2)
$His^- + H^+ \rightleftharpoons HHis$	9.16(1)	-10.19(6)	2.31(6)
$HHis + H^+ \rightleftharpoons H_2His^+$	6.13(1)	-6.9(1)	1.4(1)
$H_2His^+ + H^+ \rightleftharpoons H_3His^{2+}$	1.92(1)	2.2(2)	4.8(2)

[a] Numbers in parentheses are standard deviations in the last significant figure

Fig. S1. Aromatic zone ^{1}H NMR spectra of solutions containing **L2** and Glu in 1:4 molar ratio recorded in D_2O at pD = 4.5 (a) and pD = 7.3 (b)

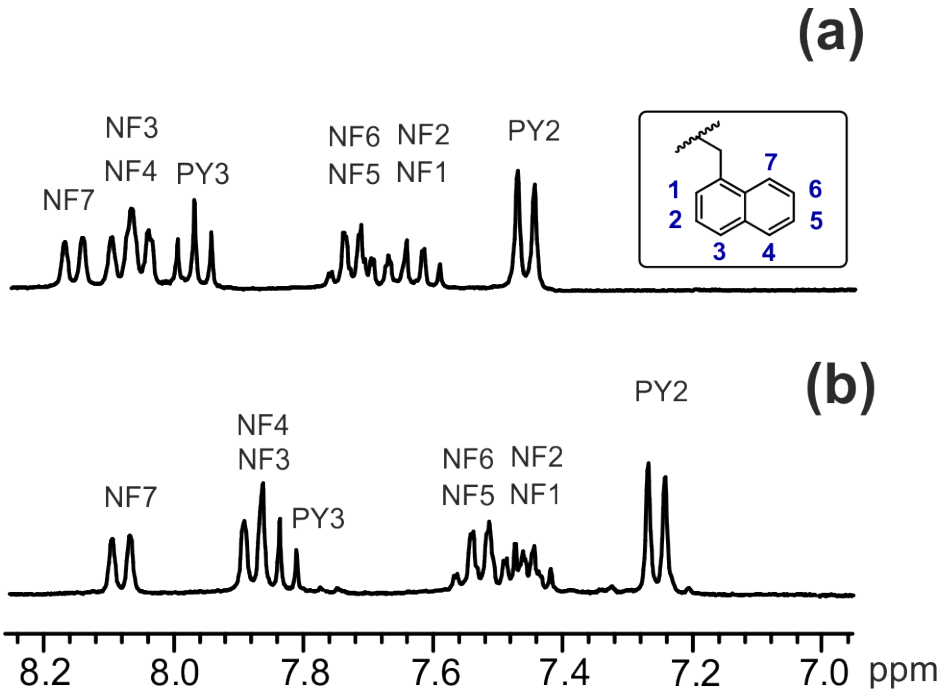

Fig. S2. Minimum energy structures calculated for the complexes [H**L1**(Asp)]$^{-}$ (a), [H**L1**(HAsp)] (b), [H_2**L1**(HAsp)]$^{+}$ (c), [H_3**L1**(HAsp)]$^{2+}$ (d), [H_3**L1**(H_2Asp)]$^{3+}$ (e).

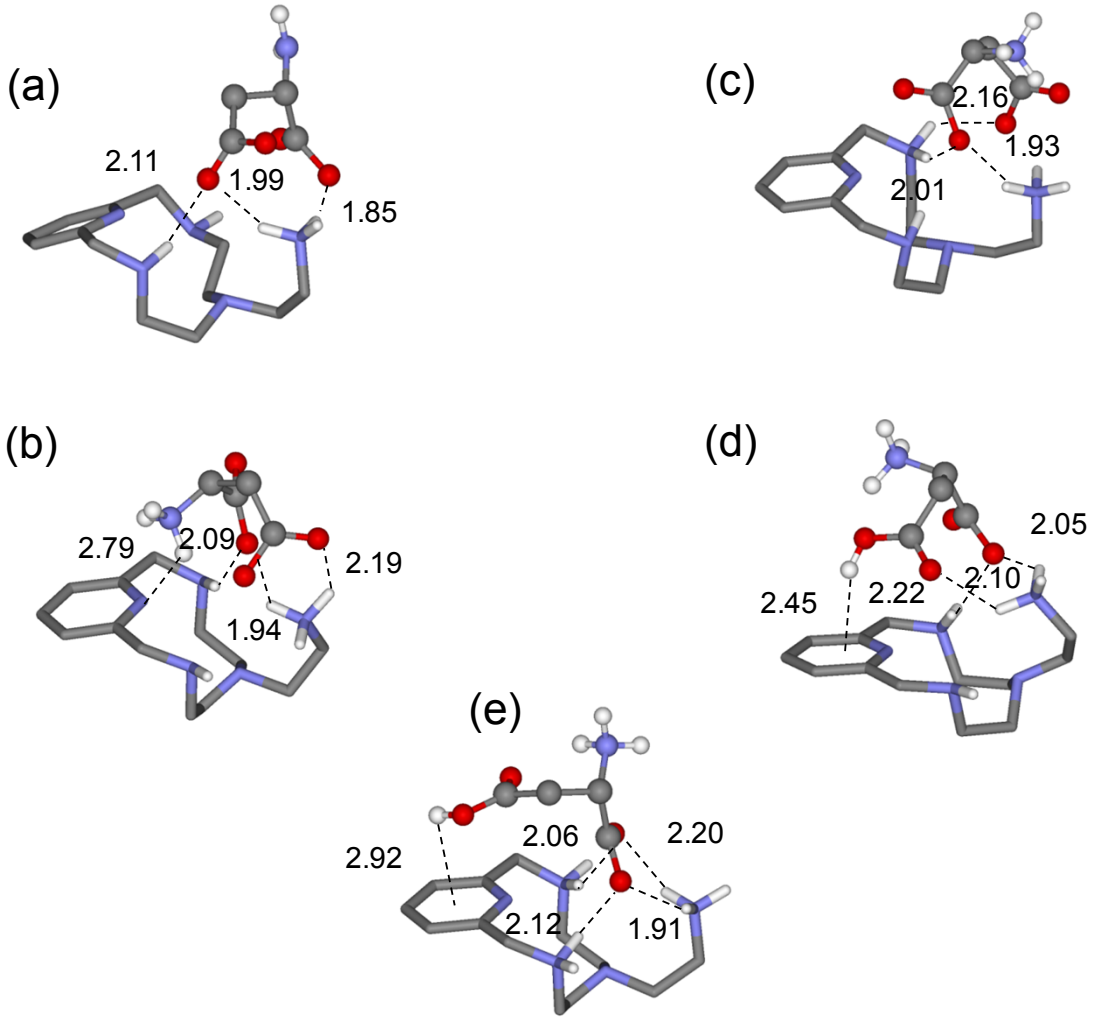

Fig. S3. Minimum energy structures calculated for the complexes [H**L1**(HAla)]$^{+}$ (a), [H_2**L1**(HAla)]$^{2+}$ (b), [H_3L(HAla)]$^{3+}$ (c).

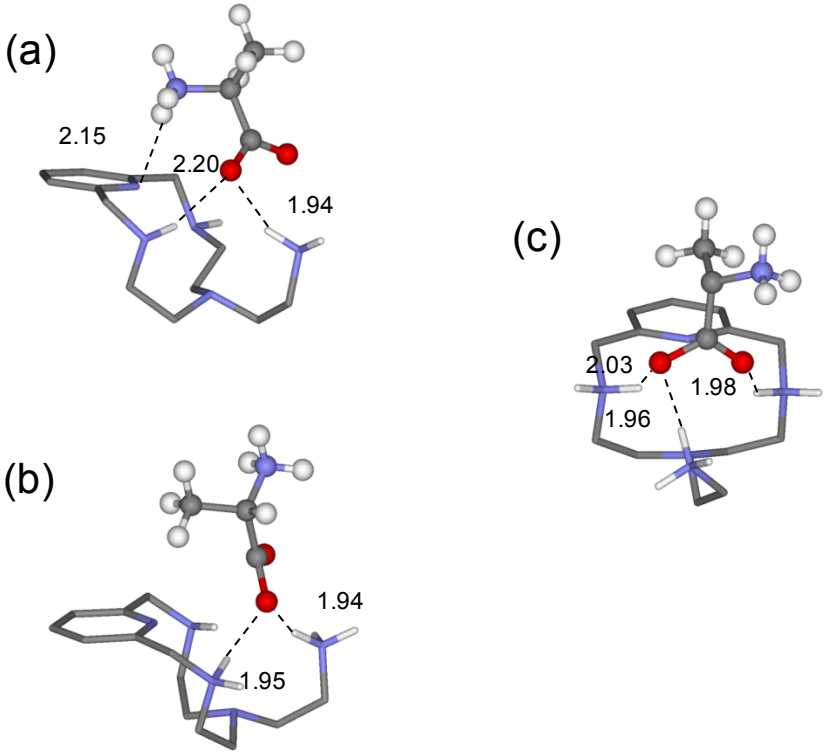

Fig.S4. Minimum energy structures calculated for the complexes [H**L1**(Trp)] (a), $[H\mathbf{L1}(HTrp)]^{+}$ (b), $[H_2\mathbf{L1}(HTrp)]^{2+}$ (c), $[H_3\mathbf{L1}(HTrp)]^{3+}$ (d).

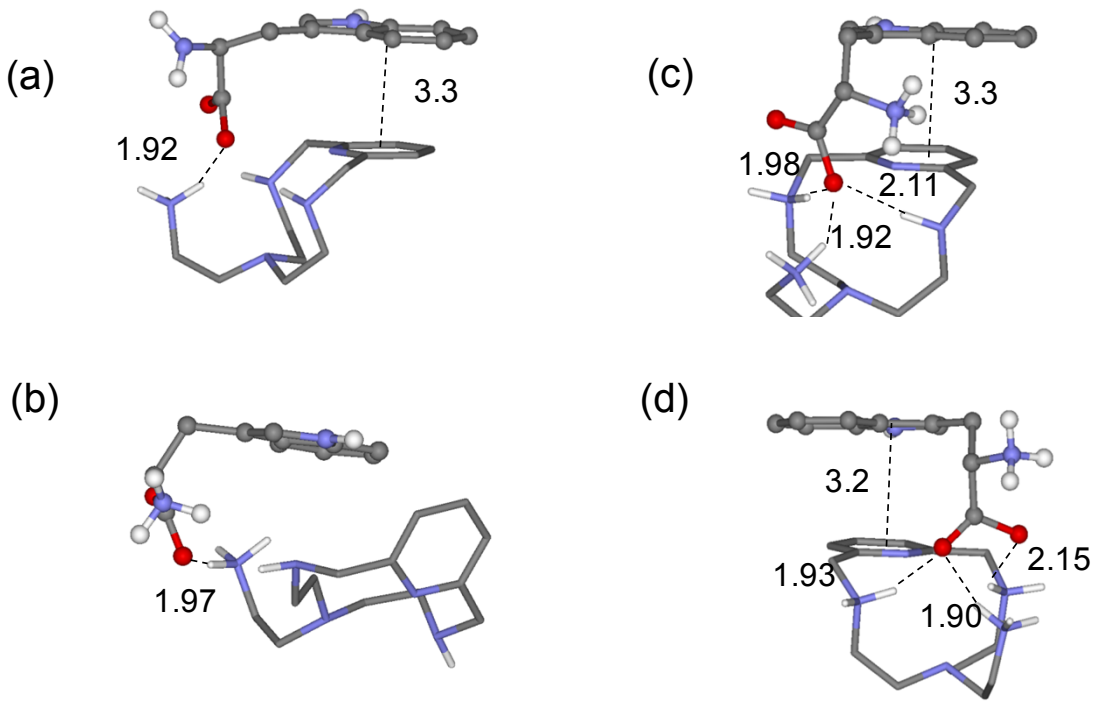

Fig. S5. Minimum energy structures calculated for the complexes [H**L1**(His)] (a), $[H_2$**L1**(His)$]^+$ (b), $[H_2$**L1**(HHis)$]^{2+}$ (c), $[H_3$**L1**(HHis)$]^{3+}$ (d), $[H_3$**L1**$(H_2$His)$]^{4+}$ (e).

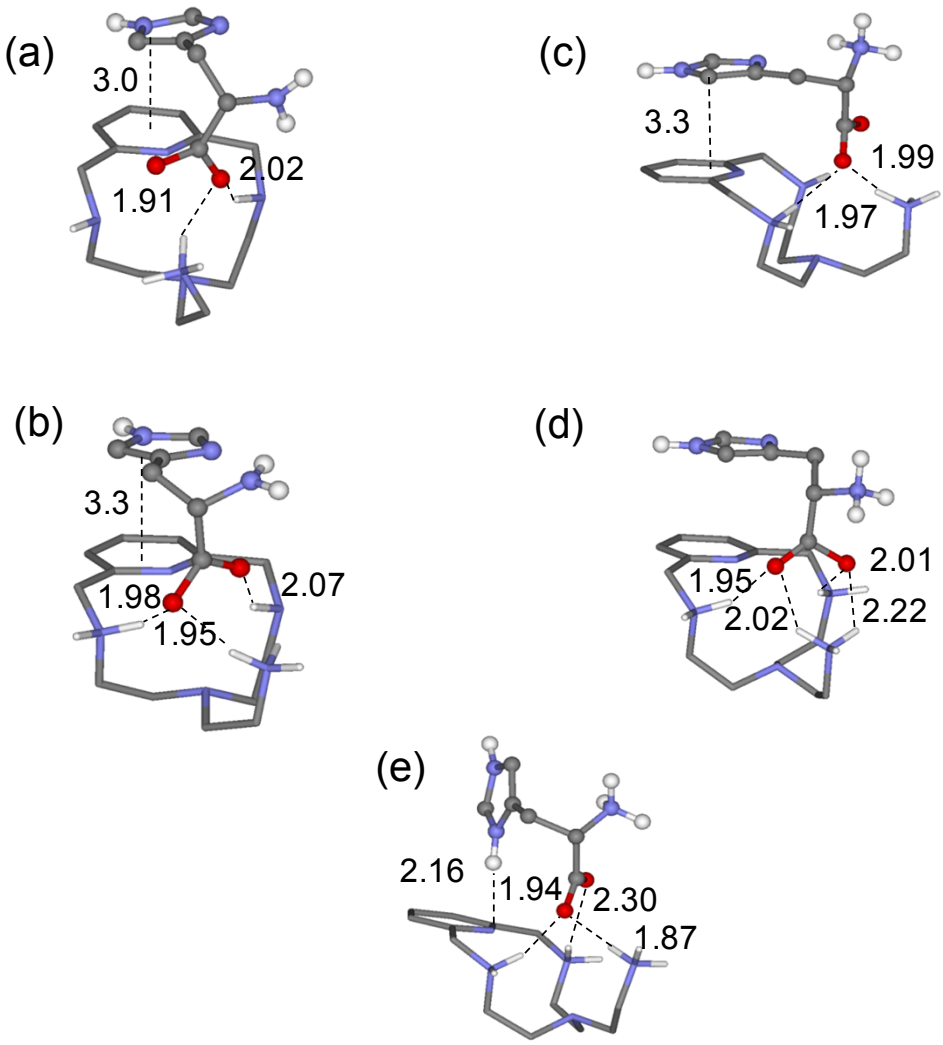

Fig. S6. Minimum energy structures calculated for the complexes [H**L1**(Phe)] (a), $[H_2\mathbf{L1}(Phe)]^{+}$ (b), $[H_2\mathbf{L1}(HPhe)]^{2+}$ (c), $[H_3\mathbf{L1}(HPhe)]^{3+}$ (d).

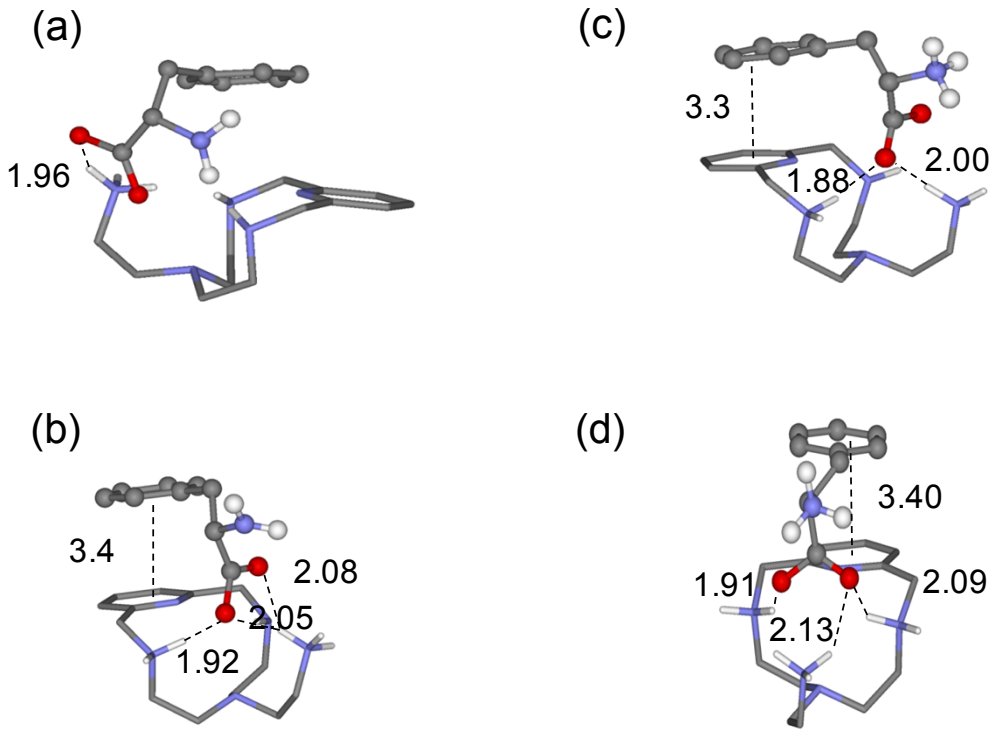

Fig. S7. Minimum energy structures calculated for the complexes [**L2**(Ala)]$^{-}$ (a), [H**L2**(Ala)] (b), [**L2**(HAla)] (c), [H**L2**(HAla)]$^{+}$ (d), [H_2**L2**(HAla)]$^{2+}$ (e).