# A Kinetic and Thermodynamic Study of the Glycosidic Bond Cleavage in Deoxyuridine

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## Supporting Information

(Figures S1 – S3 and Tables S1 to S5, 8 pages)

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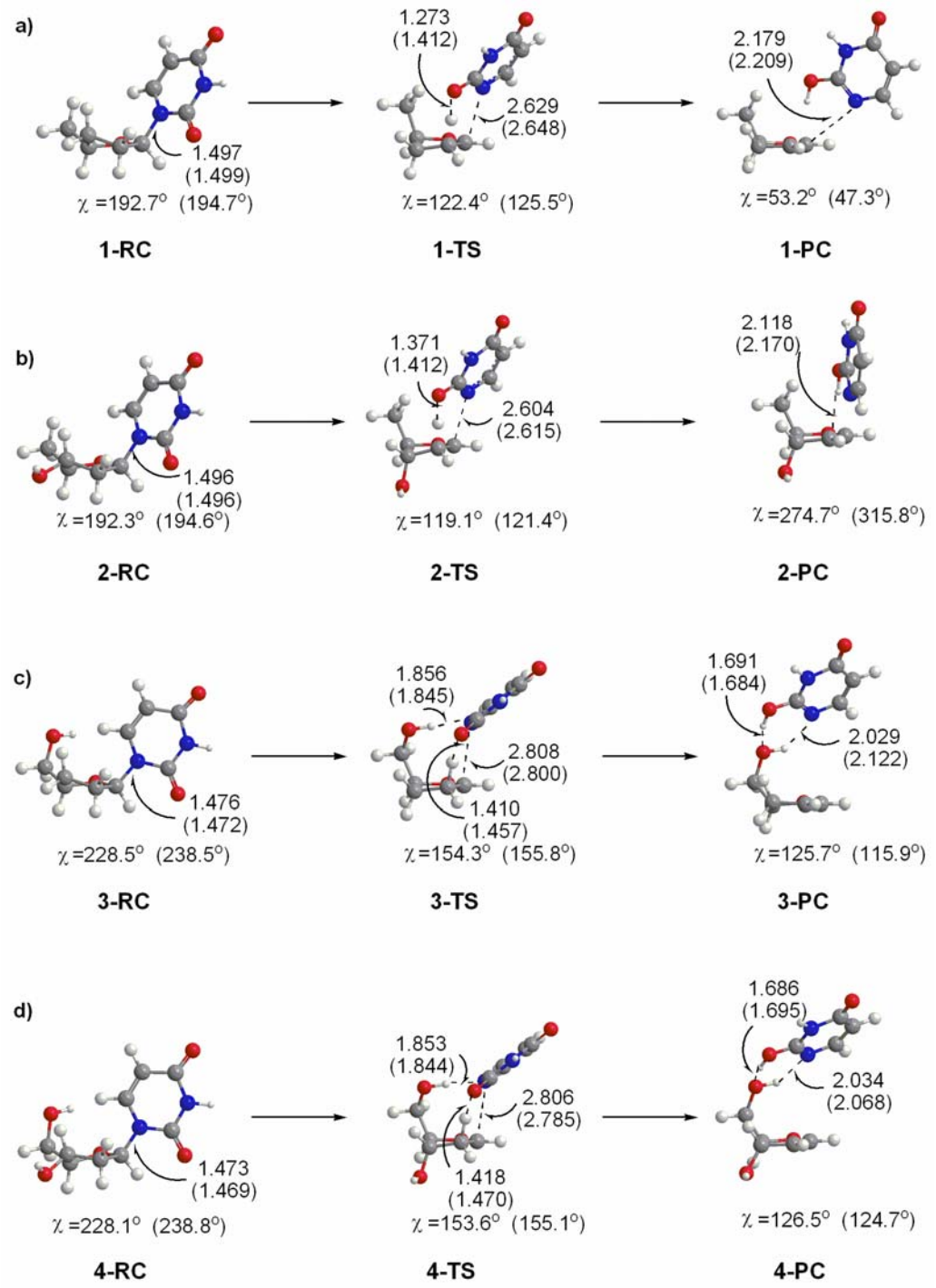


**Figure S1. Selected B3LYP/6-31G(d) bond lengths (Å), angles (deg), and dihedral angles (deg) in reactant (RC), transition state (TS) and product (PC) complexes for the unimolecular decomposition of deoxyuridine studied using models (a) 1, (b) 2, (c) 3 and (d) 4 (B3LYP/6-31+G(d,p) values in parentheses).**

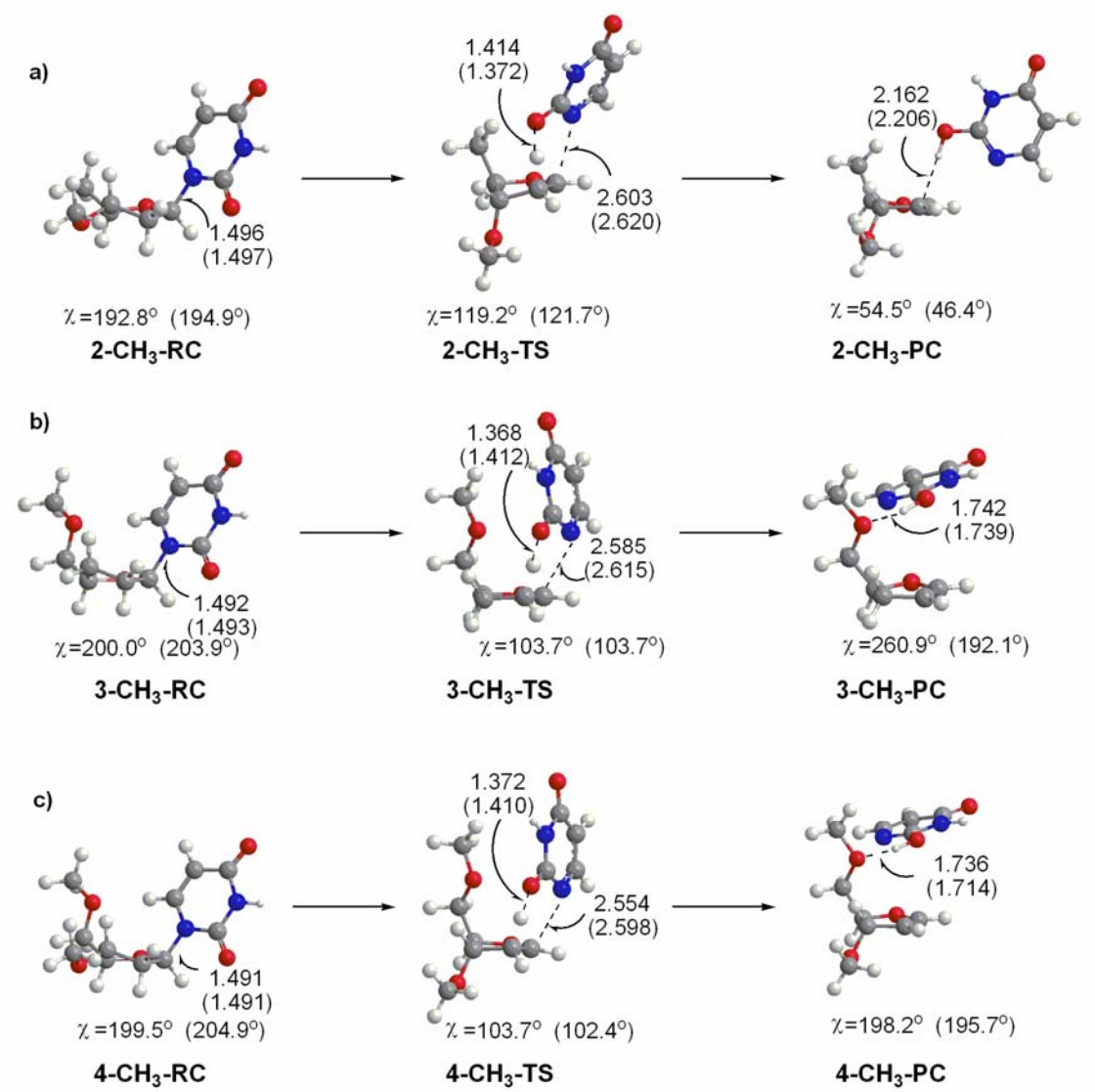


**Figure S2. Selected B3LYP/6-31G(d) bond lengths (Å), angles (deg), and dihedral angles (deg) in reactant (RC), transition state (TS) and product (PC) complexes for the unimolecular decomposition of deoxyuridine studied using models (a) 2-$CH_3$ (b) 3-$CH_3$ and (c) 4-$CH_3$ (B3LYP/6-31+G(d,p) values in parentheses).**

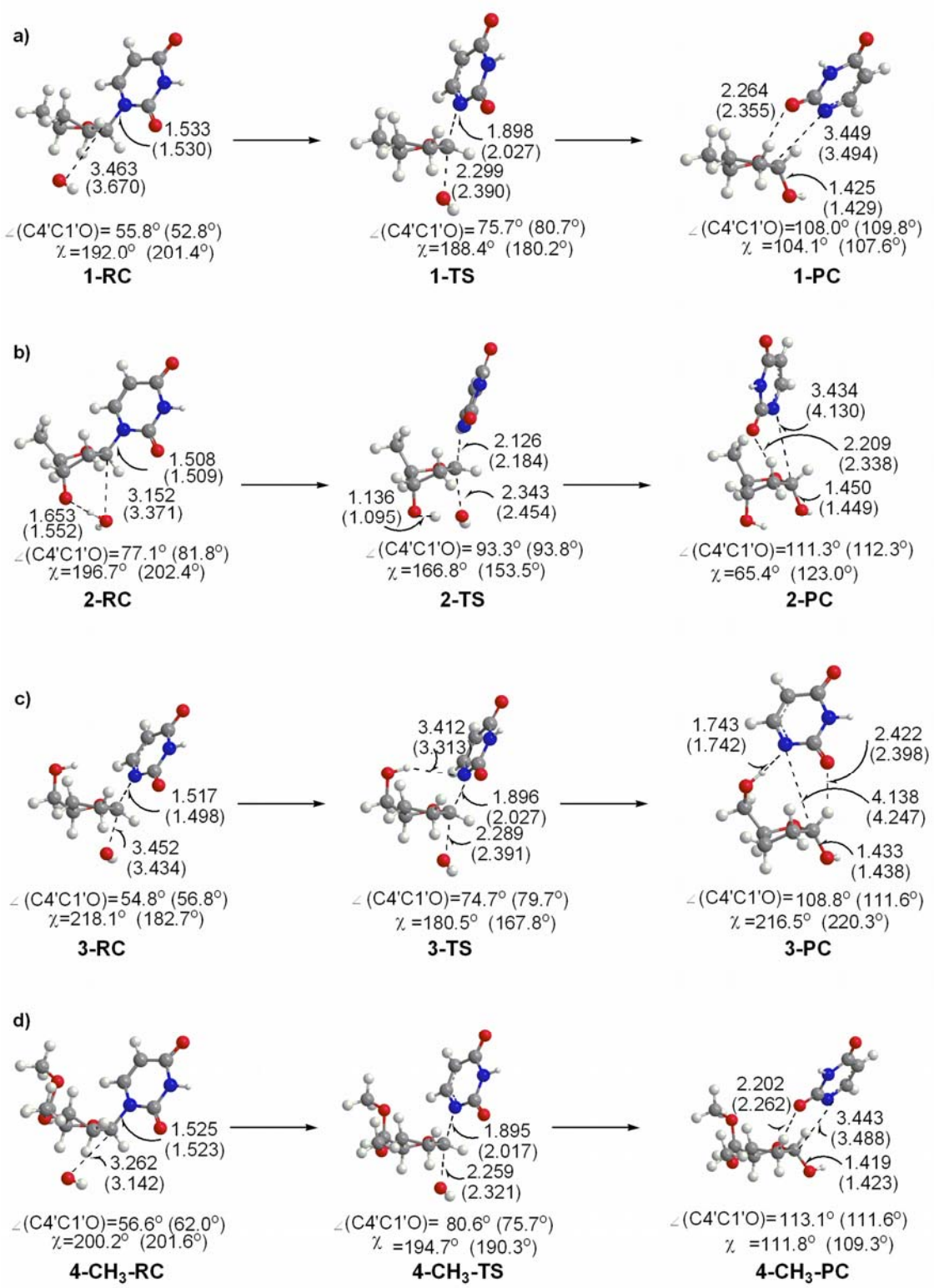


**Figure S3. Selected B3LYP/6-31G(d) bond lengths (Å), angles (deg), and dihedral angles (deg) in reactant (RC), transition state (TS) and product (PC) complexes for glycosidic bond cleavage by $HO^-$ nucleophile studied using models (a) 1, (b) 2, (c) 3 and (d) 4-$CH_3$ (B3LYP/6-31+G(d,p) values in parentheses).**

**Table S1: Barriers and Reaction Energies (kJ mol$^{-1}$) for the Unimolecular Decomposition of Deoxyuridine *in vacuo* Which Involves C2'–H Abstraction.[a,b]**

| Model[c] | B3LYP/6-311+G(2d,p)//B3LYP/6-31G(d) | | B3LYP/6-311+G(2d,p)//B3LYP/6-31+G(d) | |
|---|---|---|---|---|
| | Barrier | Reaction Energy | Barrier | Reaction Energy |
| **1** | 150.9 | 80.8 | 152.0 | 80.8 |
| **2** | 142.1 | 73.3 | 143.5 | 73.2 |
| **2-CH$_3$** | 142.1 | 73.4 | 143.2 | 73.5 |
| **3** | 136.1 | 54.6 | 138.9 | 54.3 |
| **3-CH$_3$** | 163.6 | 71.7 | 164.6 | 71.9 |
| **4** | 131.6 | 49.6 | 135.4 | 50.4 |
| **4-CH$_3$** | 156.3 | 65.2 | 158.2 | 64.7 |

[a] Scaled (0.9806) B3LYP ZPVE corrections are included in all energies. [b] See Figures S1 and S2 for selected geometrical information. [c] See Figure 1 for model nomenclature.

**Table S2: Barriers and Reaction Energies (kJ mol$^{-1}$) for Direct Hydrolysis of the Glycosidic Bond in Deoxyuridine Using B3LYP Geometries Optimized with 6-31G(d) (6-31+G(d,p) values in parentheses).[a]**

| Model | $S_N1$ | | | |
|---|---|---|---|---|
| | Barrier 1 | Intermediate Energy | Barrier 2 | Reaction Energy |
| **1** | 153.4 | 81.5 | 291.6 | -1.4 |
| | (156.9) | (81.2) | (285.5) | (2.1) |
| **4-CH$_3$** | 156.8 | 61.6 | 272.8 | 30.7 |
| | (157.7) | (63.1) | (267.5) | (31.9) |

| | $S_N2$ | |
|---|---|---|
| | Barrier | Reaction Energy |
| **1** | 159.7 | 24.4 |
| | (158.6) | (25.4) |
| **4-CH$_3$** | 165.4 | 31.2 |
| | (163.3) | (31.7) |

[a] B3LYP/6-311+G(2d,p) single-point calculations were performed on the optimized geometries. Scaled (0.9806) ZPVE corrections are included in all energies.

**Table S3: Barriers and Reaction Energies (kJ mol$^{-1}$) for Hydrolysis of the Glycosidic Bond in Deoxyuridine by $HO^-$.[a]**

| Model[b] | B3LYP/6-311+G(2d,p)//B3LYP/6-31G(d) | | B3LYP/6-311+G(2d,p)//B3LYP/6-31+G(d,p) | |
|---|---|---|---|---|
| | Energy Barrier | Reaction Energy | Energy Barrier | Reaction Energy |
| **1** | 49.5 | -161.6 | 55.1 | -149.4 |
| **2** | 76.0 | -72.9 | 80.9 | -64.7 |
| **2-$CH_3$** | 42.5 | -177.8 | 46.1 | -168.2 |
| **3** | 61.0 | -193.7 | 67.4 | -183.1 |
| **3-$CH_3$** | 61.0 | -143.4 | 66.9 | -131.2 |
| **4-$CH_3$** | 49.9 | -163.4 | 54.4 | -153.6 |

[a] B3LYP/6-311+G(2d,p) single-point calculations were performed on the optimized geometries. Scaled (0.9806) ZPVE corrections are included in all energies. [b]See Figure 1 for model designation, and Figure S3 for geometrical information.

**Table S4: Barriers and Reaction Energies (kJ mol$^{-1}$) for Hydrolysis of the Glycosidic Bond in Deoxyuridine by $HO^-$ for Model 1 with HF, $H_2O$ or $NH_3$ Bound at Various Complexation Sites in Uracil.[a,b]**

| | | | B3LYP/6-311+G(2d,p)//B3LYP/6-31G(d) | | | | B3LYP/6-311+G(2d,p)//B3LYP/6-31+G(d,p) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| O2(N3) | O4(N3) | O4(C5) | Barrier | Δ | Reaction Energy | Δ | Barrier | Δ | Reaction Energy | Δ |
| | | | 49.5 | 0.0 | -161.6 | 0.0 | 55.1 | 0.0 | -149.4 | 0.0 |
| HF | | | 36.4 | -13.1 | -188.6 | -27.0 | 41.7 | -13.4 | -177.0 | -27.6 |
| | HF | | 40.3 | -9.2 | -181.4 | -19.8 | 45.0 | -10.1 | -169.7 | -20.3 |
| | | HF | 38.3 | -11.2 | -184.1 | -22.5 | 43.7 | -11.4 | -172.7 | -23.3 |
| $H_2O$ | | | 43.4 | -6.1 | -173.7 | -12.1 | 48.9 | -6.2 | -162.0 | -12.6 |
| | $H_2O$ | | 45.1 | -4.4 | -171.0 | -9.4 | 50.8 | -4.3 | -159.2 | -9.8 |
| | | $H_2O$ | 42.6 | -6.9 | -175.3 | -13.7 | 48.6 | -6.5 | -162.9 | -13.5 |
| $NH_3$ | | | 50.2 | 0.7 | -161.7 | -0.1 | 56.5 | 1.4 | -148.0 | 1.4 |
| | $NH_3$ | | 50.7 | 1.2 | -161.4 | 0.2 | 57.1 | 2.0 | -148.2 | 1.2 |
| | | $NH_3$ | 45.5 | -4.0 | -170.1 | -8.5 | 51.3 | -3.8 | -152.7 | -3.3 |

[a] B3LYP/6-311+G(2d,p) single-point calculations include BSSE and Scaled (0.9806) ZPVE corrections. [b] See Figure 9 for definition of complexation sites

**Table S5. Barriers and Reaction Energies (kJ mol$^{-1}$) for the Hydrolysis of the Glycosidic Bond in Deoxyuridine by $HO^-$, or $CH_3O^-$ or $HCOO^-$ Activated Water with HF, $H_2O$ or $NH_3$ Bound at Various Sites in Uracil Calculated with Model 1.[a,b]**

| | | | $HO^-$ | | | | $CH_3O^-\cdots H_2O$ | | | | $HCOO^-\cdots H_2O$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O2(N3) | O4(N3) | O4(C5) | Barrier | Δ | Reaction Energy | Δ | Barrier | Δ | Reaction Energy | Δ | Barrier | Δ | Reaction Energy | Δ |
| | | | 49.5 | 0.0 | -161.6 | 0.0 | 60.5 | 0.0 | -83.2 | 0.0 | 90.8 | 0.0 | 14.3 | 0.0 |
| HF | | | 36.4 | -13.1 | -188.6 | -27.0 | 47.3 | -13.2 | -105.4 | -22.2 | 73.1 | -17.7 | -14.1 | -28.4 |
| | HF | | 40.3 | -9.2 | -181.4 | -19.8 | 50.6 | -9.9 | -102.1 | -18.9 | 78.8 | -12.0 | -8.2 | -22.5 |
| | | HF | 38.3 | -11.2 | -184.1 | -22.5 | 50.1 | -10.4 | -100.9 | -17.7 | 77.0 | -13.8 | -5.9 | -20.2 |
| $H_2O$ | | | 43.4 | -6.1 | -173.7 | -12.1 | 56.2 | -4.3 | -88.9 | -5.7 | 87.4 | -3.4 | 2.3 | -12.0 |
| | $H_2O$ | | 45.1 | -4.4 | -171 | -9.4 | 64.1 | 3.6 | -82.8 | 0.4 | 88.7 | -2.1 | 5.2 | -9.1 |
| | | $H_2O$ | 42.6 | -6.9 | -175.3 | -13.7 | 55.1 | -5.4 | -93.8 | -10.6 | 85.2 | -5.6 | 0.5 | -13.8 |
| $NH_3$ | | | 50.2 | 0.7 | -161.7 | -0.1 | 71.8 | 11.3 | -69 | 14.2 | 98.3 | 7.5 | 20.2 | 5.9 |
| | $NH_3$ | | 50.7 | 1.2 | -161.4 | 0.2 | 72.0 | 11.5 | -68.4 | 14.8 | 98.0 | 7.2 | 16 | 1.7 |
| | | $NH_3$ | 45.5 | -4.0 | -170.1 | -8.5 | 57.4 | -3.1 | -90.6 | -7.4 | 90.1 | -0.7 | 9.1 | -5.2 |

[a] B3LYP/6-311+G(2d,p) single-point calculations were performed on the 6-31G(d) geometries. Scaled (0.9806) ZPVE corrections are included in all energies. [b] See Figure 9 for definition of complexation sites.